1979

# The Development of the Louisiana Oyster Industry in the 19th Century.

Karen Miriam Wicker
*Louisiana State University and Agricultural & Mechanical College*

# THE DEVELOPMENT OF THE LOUISIANA OYSTER INDUSTRY IN THE 19TH CENTURY

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Geography and Anthropology

by
Karen M. Wicker
B.A., Mary Washington College of
the University of Virginia, 1970
M.S., Louisiana State University, 1975
May 1979

ACKNOWLEDGMENTS

The author wishes to express her sincere gratitude to the following people who have contributed to the final realization of this dissertation:

To Dr. H. J. Walker, my major advisor, for his guidance and constructive criticism in the preparation of this dissertation;

To Dr. T. B. Ford and Dr. W. G. McIntire who guided me in formulating more clearly my research topic. I especially wish to thank Dr. Ford for the information he shared with me concerning the Louisiana oyster industry and for his patient guidance throughout this project;

To Dr. Bahr, Dr. Muller, Dr. Kesel and Dr. Hilliard for reading the dissertation and offering suggestions for improvement;

To Mrs. R. Scull and Mr. J. Hoover of the Louisiana State University Library who were especially helpful in locating the necessary reseach documents for my study;

To Mr. Schafer, Mr. Fairman and other personnel of the Louisiana Wild Life and Fisheries Commission for making the department's oyster records available and for their informative comments on the Louisiana oyster industry;

To Mr. Kemp and assistants at the Louisiana State Museum in New Orleans who aided me in locating numerous historic documents pertaining to Louisiana's oyster industry;

To Ms. Joyce Nelson of the L. S. U. Geoscience Map Library who greatly facilitated my search for historic maps;

To Mr. Lobrano, Clerk of Court for Plaquemines Parish who generously consented to discuss his knowledge of the oyster industry and to show me the records available at the court house;

To Dr. M. M. Vujnovich, a very gracious professor, who took the time

to discuss with me the Louisiana oyster industry, especially with regard to the involvement of the Yugoslavs, and who contributed immensely to my understanding of this subject.

Finally, I thank everyone who gave of their time, their patience, and their experience to discuss various aspects of this dissertation, both the research and preparation, and to give me their help and advice. The ability to communicate with others when preparing a research paper is one of the most valuable experiences one can achieve at an academic institution.

TABLE OF CONTENTS


Page

ACKNOWLEDGMENTS..... ii

LIST OF TABLES..... vi

LIST OF FIGURES..... vii

ABSTRACT..... ix

Chapter

I. INTRODUCTION..... 1

Literature Review..... 3
Literature Pertaining to the Louisiana Oyster Industry.... 5
Louisiana's Position As An Oyster Producer..... 8

II. THE DISTRIBUTION OF OYSTERS ACCORDING TO THEIR PHYSIOLOGICAL REQUIREMENTS AND THE PHYSICAL ENVIRONMENT..... 13

The Physiological Requirements of Oysters..... 14
The Physical Environment of Coastal Louisiana..... 17
Deltaic Processes..... 19
Changes in Coastal Physiography Related to Deltaic Activity..... 23
Relationship Between Viable Oyster Reefs and Phases Within the Delta Cycle..... 28
Influence of the Physical Environment on Types of Commercial Oysters in Louisiana..... 32

III. DISTRIBUTION AND CONDITION OF NATURAL OYSTER BOTTOMS IN LOUISIANA IN THE LATE 19TH AND EARLY 20TH CENTURIES..... 38

Early Classification and Description of Major Oyster Growing Bottoms..... 38
Variations in the Quality of Oyster Bottoms in Coastal Louisiana..... 42
Louisiana Marsh..... 43
East of the Mississippi River..... 48
The Mouth of the Mississippi River..... 49
West of the Mississippi River..... 49
Barataria Bay..... 51
Timbalier and Terrebonne Bays..... 52
Terrebonne Bay to Four League Bay..... 53
South West Pass..... 54
Atchafalaya Bay to Vermilion Bay..... 55
Calcasieu Lake..... 55

IV. DEVELOPMENT OF THE OYSTER INDUSTRY IN LOUISIANA..... 57

Harvesting from Natural Reefs..... 57
Expansion of the Industry Through Cultivation..... 62

Initial Cultivation Sites and Variations in Practices..... 63
Whale Bay..... 64
Bayou Cook..... 66
Grand Bay..... 67
Pioneers in Oyster Cultivation..... 68
Development of Cultivation Techniques..... 75
Tools Associated with Initial Oystering Activities..... 85
Transportation and Marketing Procedures..... 91
Legislation Fostering Development of Louisiana's Oyster Industry..... 106
Initial legislation..... 108
Objections to the initial legislation..... 109
Revision of previous legislation..... 110
Stronger legislation in the 1890s..... 112
Professional recommendations..... 114
Louisiana's first comprehensive oyster law..... 117

V. AREAL EXTENT AND DISTRIBUTION OF THE OYSTER INDUSTRY IN 1902..... 123

Distribution of Oyster Leases in 1902..... 125
Ethnic Origin of Early Louisiana Oystermen..... 126
Environmental and Cultivation Conditions Evidenced by Lease Data..... 127

VI. SUMMARY AND CONCLUSIONS..... 142

BIBLIOGRAPHY..... 152

APPENDIX

1. GLOSSARY..... 164

2. LOUISIANA'S COMMERCIAL OYSTER CRASSOSTREA VIRGINICA GMELIN: ITS BIOLOGY AND ENVIRONMENTAL FACTORS INFLUENCING ITS GROWTH, REPRODUCTION AND DISTRIBUTION..... 168

3. POSSIBLE CORRELATION BETWEEN ETHNIC ORIGIN AND DEVELOPMENT OF THE LOUISIANA OYSTER INDUSTRY..... 192

4. OYSTER LEASE DATA--1902..... 209

VITA..... 214

LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1. | Relationship Between Location Within A Typical Gulf Coast Estuary, Variations in Environmental Parameters and Commercial Value of Oysters | 33 |
| 2. | Major Steps in Oyster Cultivation Using Seed | 78 |
| 3. | Number and Value of Tongs Used in Oyster Fisheries in Louisiana in 1889 and 1890 | 88 |
| 4. | Major Marketing Classes of Oysters in New Orleans According to Value, Quality and Origin | 94 |
| 5. | Comparison of 1880 and 1890 Data Concerning Employment, Capital Investment, Value and Amount of Fisheries Products and Oysters | 103 |
| 6. | Production of Oysters in Louisiana: 1892, 1902-1908 | 120 |
| 7. | Statistics on Oyster Ground Leases in Louisiana in 1902 | 126 |
| 8. | Relationship Between Leases in a Parish and Ownership According to Ethnic Surname | 127 |
| 9. | Number of Tongers and Vessels listed with Oyster Leases Recorded in 1902 | 134 |
| 10. | New State Lease Numbers Assigned to Older Parish Leases | 137 |
| 11. | Environmental Parameters Affecting Oysters | 179 |
| 12. | Census Data Available for Oyster Producing Parishes in Louisiana Between 1820 and 1880 | 193 |
| 13. | 1850--Number of Fishermen in Oyster Producing Parishes | 194 |
| 14. | 1860--Number of Fishermen in Oyster Producing Parishes | 195 |
| 15. | 1870--Number of Fishermen in Oyster Producing Parishes | 196 |
| 16. | 1880--Number of Fishermen in Oyster Producing Parishes | 197 |
| 17. | Fishermen in Louisiana Listed According to Place of Origin and Percentage of Total Number of Fishermen for Each Census | 199 |
| 18. | Number of Men in Oyster Related Occupations | 199 |

LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1. | Location of Louisiana With Regard to the "Fertile Fisheries Crescent" and Movement of the Gulf's Surface Currents..... | 9 |
| 2. | Major Physiographic Regions in Coastal Louisiana and Average Rates of Coastline Change..... | 20 |
| 3. | Location of Major Mississippi River Delta Lobes During the Last 12,000 Years..... | 22 |
| 4. | Location and Subaerial Extent of Two Recent Delta Lobes, Lafourche and Plaquemines-Balize..... | 24 |
| 5. | Alteration of the Coastal Environment in Response to Alternating Progradational and Degradational Processes of an Active, Shifting Mississippi Delta..... | 25 |
| 6. | Comparison of Maps Showing the Rapid Rate of Erosion in the Abandoned Lafourche Delta Complex..... | 29 |
| 7. | A Graph of Environmental Diversity and Biological Productivity as a Function of the Delta Cycle..... | 30 |
| 8. | Distribution of Major Commercial Oyster Types Within a Typical Gulf Coast Estuary..... | 34 |
| 9. | Condition of Natural Oyster Bottoms in the Louisiana Marsh in 1897..... | 39 |
| 10. | Map of the Extent and Condition of Louisiana Oyster Bottoms in 1897..... | 40 |
| 11. | Map of the Extent and Condition of Louisiana Oyster Bottoms in 1920..... | 41 |
| 12. | Distribution of Known Archeological Sites in Coastal Louisiana..... | 58 |
| 13. | Oyster Shells Around the Base of a Typical Oysterman's Camp in the Louisiana Marshes..... | 67 |
| 14. | An Example of a Rather Crude Type of Oyster Camp Erected on Bayou Brouleau in the Louisiana Marshes..... | 74 |
| 15. | An Example of a More Substantial Oyster Camp Located in the Marshes of Coastal Louisiana..... | 75 |
| 16. | Tonging Oysters From Grounds Located in Shallow Water in Coastal Louisiana..... | 76 |

17. Culling Oysters in Order to Separate the Market Size from Those Requiring Further Growth..... 76

18. Oysters Being Shoveled from a Skiff onto Private Oyster Beds Located in a Shallow Tidal Channel in the Louisiana Marshes..... 80

19. A Fenced, Private Oyster Bedding Ground Located West of the Mouth of the Mississippi River..... 80

20. Examples of Tongs and Nippers Used in the Gathering of Oysters..... 86

21. Type of Oyster Dredge Used in the Oyster Industry in the Late 19th Century..... 89

22. A Typical Oyster Dredge Boat Used to Harvest Oysters from Private Grounds and Natural Reefs in Coastal Louisiana and and Mississippi..... 91

23. Major Market Routes Whereby Oysters Were Transported from Harvesting Sites to Market..... 93

24. Vessels Unloading Cargo at the Old Basin Canal in the early 1880s..... 95

25. Oysters Being Unloaded from Luggers Docked at the French Market Landing Around the Turn of the 20th Century..... 96

26. Luggers Transporting Cargo from the Barataria Bay Region of Louisiana..... 98

27. Map of the Distribution of Oyster Leases Recorded in 1902 by the Louisiana Department of Conservation..... 124

28. Drawing of the Exterior and Interior Portions of an Oyster Shell..... 170

29. Internal Anatomy of an Oyster, Crassostrea Virginica..... 172

30. Spawning and Early Development of an Oyster, Crassostrea Virginica..... 176

31. Oyster Cultivation in Lake Fusaro, Italy in the mid-19th Century..... 203

32. Collection of Spat on Stakes Driven Around Oyster Deposits in Lake Fusaro, Italy..... 203

ABSTRACT

The Louisiana oyster industry, emerging in the early 19th century, expanded rapidly until it ranked fourth in the nation in oyster production at the turn of the 20th century. Under natural conditions, oysters grow abundantly in the estuarine areas of the Mississippi deltaic plain where the positive environmental parameters such as firm substrate, adequate current, proper salinity and temperature ranges and suitable food supplies exceed the negative environmental parameters which include sedimentation, pollution, competition and commensalism, disease and predation. However, the initial harvesting sites were located in the lower Mississippi River delta because in addition to the abundant oyster growth, there was a willing and capable work force to exploit the resource. Furthermore, New Orleans, located near the exploitable oyster reefs and on the Mississippi River which supplied an inexpensive means of transportation, constituted a large and growing market demand which in turn encouraged expansion of the oyster enterprise.

As the oyster resources were depleted in the lower delta because of unwise harvesting practices and changes in environmental conditions, oystermen were forced to expand their operations throughout the Mississippi deltaic plain in order to secure both marketable oysters and seed to transplant to the commercial grounds along the Mississippi River. This constant shift of oyster harvesting and later cultivation sites in response to the changes characteristic of Louisiana's dynamic coastal environment is a distinguishable feature of the Louisiana oyster industry.

Cultivation of oysters in Louisiana developed in response to depletion of natural reefs in the lower delta and to the ability of certain ethnic groups, especially the Slavonians, to undertake successful arti-

ficial propagation. In many cases, these oystermen adapted Old World tools and boats to their trade and modernized them as soon as possible in order to increase their profits.

The obvious depletion of oyster resources in Louisiana by the late 19th century resulted in demands for legislation to protect the natural resource as well as the private property rights of those with cultivated holdings. After a series of unsatisfactory laws, a comprehensive oyster law, passed in 1902, permitted private leasing of oyster growing bottoms from the state, as well as protection of the resource and promotion of the industry. By the turn of the 20th century, cultivation was a well established component of the Louisiana oyster industry and with Louisiana's abundant natural resources and adequate legislation, the industry was able to expand until it was number one in the United States in the late 20th century.

# CHAPTER I

## INTRODUCTION

The purpose of this study is to document the early development of the Louisiana oyster industry in terms of the cultural and physical environmental factors relating to man's adjustment to and exploitation of the natural environment and its resources. The time period involved covers approximately eighty years and extends from the early 19th century until just after the turn of the 20th century. A study of the oyster industry encompasses parallel aspects of physical geography and marine science in that it establishes the relationship between the physiological requirements of oysters and their distribution in coastal Louisiana in the 19th century. Furthermore, the distribution is shown to be a function of Louisiana's coastal geomorphology, especially the cyclic stages of the shifting Mississippi River delta. The interrelationships between the physical environment and cultural factors involved in oystering help to explain the manner in which the industry developed and why Louisiana's oyster industry differed in several significant features from oyster industries elsewhere in the United States during the 19th and early 20th centuries.

The historical and cultural geographical aspects of this report center on the prominent pioneers in the industry, the first areas where oystering was concentrated, and the development of the methods and tools utilized in the industry. The recognition of oysters as a natural resource and the subsequent development of an industry to cultivate, harvest, market, and preserve the resource is a study in man-land relationships, one of the four major traditions in geography (Pattison, 1964). The historical evolution of a sea food industry and the

resolution of problems involving supply and demand are also common topics in the marine science discipline.

An analysis of the 19th century oyster industry in terms of the interrelationships between man's exploitation of a recognized resource and the physical environment which is a major controlling force in both natural oyster distribution and selection of cultivated grounds had not been written prior to this study. This documentation was accomplished by researching the relevant historical data and mapping the physical environmental parameters and the distribution of natural and cultivated grounds and harvesting and marketing activities. A systematic approach is essential to understanding the initial formation, location, and subsequent dispersal of the industry along the Louisiana coast. Establishment of the historical background permits a better understanding of the location and condition of the present Louisiana oyster industry.

In order to compile a historic summary of the Louisiana oyster industry a variety of published material was analyzed. Data on lease size, ownership and location, ethnic origin of early oystermen, tools, harvesting and marketing methodology and legislation were obtained from various sources and then cross-checked for accuracy. Scientific data regarding oyster physiology and environmental conditions associated with deltaic processes substantiated personal accounts of early oystermen and authors thereby permitting a discussion of the interrelationship of cultural and physical factors which influenced the formation and character of the Louisiana oyster industry in the 19th century.

The period of study concludes shortly after the year 1902, because this date serves as a milestone in the history of the Louisiana oyster industry. It represents a break between the early formative years when

regulation and growth of the industry was sporadic, and the 20th century when the industry experienced rapid expansion, intensive research, and responsible state regulation. Although the business of oystering had expanded to cover virtually all of coastal Louisiana by the turn of the century, it was not fully able to establish itself as a viable industry until the state assumed the responsibility of guaranteeing private ownership of oyster planting grounds and perpetuation of oyster seed reefs as a naturally renewable resource.

## Literature Review

An analysis of four major English oyster bibliographies (Stevenson, 1894; Baughman, 1948; Korringa, 1952; Joyce, 1972) provides an overview of major published material available and is a summary of the state of knowledge concerning oysters from the late 18th to the late 20th century. The earliest bibliography (Stevenson, 1894) contains 546 annotated references published between 1665 and 1894. Of the 294 articles issued in the United States, 73 were written by personnel of the United States Commission of Fish and Fisheries [U.S.C.F.&F.]. A major portion of these articles concerns the economic value of oysters, especially the conditions favorable for natural oyster growth and cultivation, and market conditions in western Europe and the United States. An almost equal number of articles are devoted to the oyster's natural history which includes distribution, anatomy, habits and mode of life, embryology and natural reproduction and artificial propagation experiments.

Baughman's (1949) annotated bibliography is the most extensive listing of oyster articles up to the mid-20th century. In addition to articles on oyster biology and the state of the industry in various parts of the world, this bibliography is the first to include articles on

pollution problems facing the industry.

Korringa's "Recent Advances in Oyster Biology"(1952) also reviews the literature pertaining to advances made in the study of oysters by the mid-20th century. He reviews articles concerning taxonomy, evolution, anatomy, chemical composition, histochemical studies, biochemistry, respiration, anaerobic life, feeding, digestion, fattening, growth, ecological range, gonad development, fecundity, spawning, fertilization, embryology, pelagic life, setting, natural beds, heredity and selection, geographical distribution, diseases, parasites, predators, and competitors. In his survey, Korringa states that controversy over the oyster's taxonomy is resolved, but the questions on feeding remain controversial. He also notes that "since a quantitative understanding of many food chains and of the potential productivity of inshore waters is still very fragmentary, it has not yet been possible to find a satisfactory explanation for the fact that oysters thrive especially well under certain estuarine conditions and not under others." He further reveals that information on heredity, disease and causes of high mortalities in oysters is lacking in the early 1950s and this would complicate the study of oysters under conditions of competition and stress from unapparent causes.

The most recent and probably most thorough annotated oyster bibliography was published by Joyce (1972) and covers 55 categories and approximately 236 subcategories of oyster topics. The majority of the studies listed concern the anatomy and behavior of individual oysters, especially with reference to environmental conditions that affect their profitable cultivation and marketing. A review of the publications annotated in these bibliographies provides some background on the

material available on the oyster industry in Louisiana and elsewhere in the world.

A review of the general studies of the oyster industry located elsewhere in the United States (Alford, 1972; May, 1971; Matthiessen, 1970; Hofstetter, 1967; Matthiessen, et al, 1966; Shaw, 1965; 1970; Barrett, 1962; Menzel, 1962; Bailey, 1958; Orcutt, 1958; Found, 1957; McHugh and Bailey, 1957; Steele, 1957; Lopant, 1954; Baughman, 1950; Chestnut, 1949; Grave, 1905; DeBroca, 1876) and abroad (Medcot, 1961; Millar, 1961; Quayle, 1956; Cole, 1956; Galtsoff, 1951; Needler, 1941; Gutsell, 1923; Stafford, 1913; Dean, 1893; Fullarton, 1891; Goode, 1884; Brocchi, 1884; Bouchon-Brandely, 1880; Mobius, 1880; Dean, 1893) provides a valuable insight into the methods applicable for documenting the Louisiana oyster industry. However, this research indicates that despite the many articles written on oysters, and especially the historical development of cultivation and marketing, only a small portion involves the Louisiana oyster industry, and no one article provides a detailed, comprehensive discussion of the early development of the Louisiana oyster industry.

## Literature Pertaining to the Louisiana Oyster Industry

There is a paucity of material documenting the Louisiana oyster industry in the first half of the 19th century. A search of early newspapers (Louisiana Gazette, 1805; 1814) indicates that oysters enjoyed a ready market in New Orleans at the beginning of the 19th century. One British consular report (The Field, 1869) also verified the fact that Louisiana was producing oysters on a commercial basis by the mid-19th century. However, it is not until the turn of the century that newspaper and magazine articles (Daily Picayune, 1881; 1892a,b,c,d; 1902a,b; Dennett, 1883; The Daily States, 1889; Louisiana State Museum Scrapbook

[L.S.M.S.], 74A; Sea World, 1880) and personal accounts of oystermen operating at the turn of the 20th century (Bilich, 1931; Ciblic, 1977) provide valuable information on various segments of the industry such as oyster legislation, condition of natural oyster grounds, market conditions, oyster quality, harvesting and marketing procedures and natural disasters. Several 20th century articles are especially informative because of their accounts of the ethnic origins and cultivation practices of 19th century oystermen (Padgett, 1960; Lovrich, 1960; Pausina, 1970; Vujnovich, 1974). Federal census surveys for oyster producing parishes (U.S. Census 1820-1880) provide a limited amount of information on the ethnic origins of Louisiana oystermen.

Data generated from published Federal census surveys in the 1880s and 1890s (U.S.C.F.&F., 1883; 1887a,b; Ingersoll, 1889; Collins and Smith, 1891; Collins, 1892; Zacharie, 1897, 1898) include some of the earliest, though very approximate, statistics on Louisiana oyster fishermen and their enterprise. These data, which cover the number of fishermen, their country of origin, the size and value of their catch and the type of equipment used, give some indication of the state of the industry by the late 19th century, and they help to corroborate information obtained from other less direct sources.

Another valuable source of original data are the Federally conducted surveys (Moore, 1898; Moore and Pope, 1910) describing oyster production in Louisiana in the late 19th and early 20th centuries. When evaluated in conjunction with other data such as early maps (Talcott, 1839; U.S. Coast and Geodetic Survey [U.S.C.&G.S.], 1910; U.S. Geologic Survey [U.S.G.S.], 1922; Mississippi River Commission, 1895), oyster biology (Galtsoff, 1964; Van Sickle, et al, 1976; Butler, 1954) and geomorpho-

logical and hydrological processes of coastal Louisiana (Coleman, 1966; Coastal Environments, Inc. [C.E.I.], 1977; Frazier and Osanik, 1968; Gagliano and Van Beek, 1970; Morgan, 1974; Morgan and Larimore, 1957), the material is instrumental in explaining many of the changes that occurred in the industry during its formative years of the late 19th and early 20th centuries.

State generated reports pertaining to the Louisiana oyster industry were not common until the turn ofthe 20th century. In 1897, the Gulf Biologic Station was established at Cameron, Louisiana (Taylor, 1897) in order to research the biology of Gulf coast marine organisms. Several of the station's early reports described oyster culture in Louisiana (Glaser, 1904; Cary, 1904; 1907; Gates, 1910) in the early 20th century and in doing so provide valuable insight into the progress of oyster cultivation in Louisiana up to that period. Also initiated at the turn of the century were a series of state reports describing the extent and condition of natural and cultivated oyster bottoms in Louisiana as well as programs aimed at promoting the industry. The first annual report of the Oyster Commission of Louisiana was prepared by Dymond in 1904 and described the industry at that time. Annual reports were issued by the Oyster Commission until 1912 when the Department of Conservation was established. This division issued biennial reports until 1943. In 1944, the Division of Oysters and Water Bottoms was formed and proceeded to issue its own series of biennial reports up to the present. While a review of these reports provides a better understanding of the 20th century development and position of oyster cultivation in Louisiana, the earlier survey reports (Payne, 1914; 1918; 1920) show the extent of leased grounds at the turn of the 20th century. When compared to earlier

reports of oyster harvesting and cultivation, they indicate expansion of the industry under state supervision.

The first state recorded oyster plats (Louisiana Department of Conservation [L.D.C.], 1902) give a fair indication of the geographical distribution of the oyster industry at the turn of the century. Despite the small number of leases registered in the first year of state leasing, the data provided are valuable because they can be analyzed in view of other historical and geographical information to provide for the first time a portrait of the early Louisiana oyster industry. These lease plats indicate the nationality of early lease holders, their lease location, the size of their enterprise, and the types of transactions accompanying the early leasing of private oyster grounds.

A number of general articles published in the 20th century also describe the Gulf coast and Louisiana oyster industry with regard to overall cultivation and marketing practices (Kellogg, 1910; Churchill, 1920; Seferovich, 1938; Gunter, 1949; Owen, 1955; Schlesselman, 1955; St. Amant, 1958). Finally, when all of this information is assimilated and evaluated for accuracy, a description of the development of the oyster industry in Louisiana emerges.

## Louisiana's Position As An Oyster Producer

Coastal Louisiana's position in the center of the Gulf coast's "fertile fisheries crescent" (Gunter, 1967; Fig. 1) provides the state with one of the most productive fisheries industries in the world. Oysters have always constituted a significant portion of the total amount of seafood extracted from this region. In the 1890s, half of the state's fishery output was oysters (Daily Picayune, 1892c), most of which were consumed locally. During those years, the state ranked fourth in

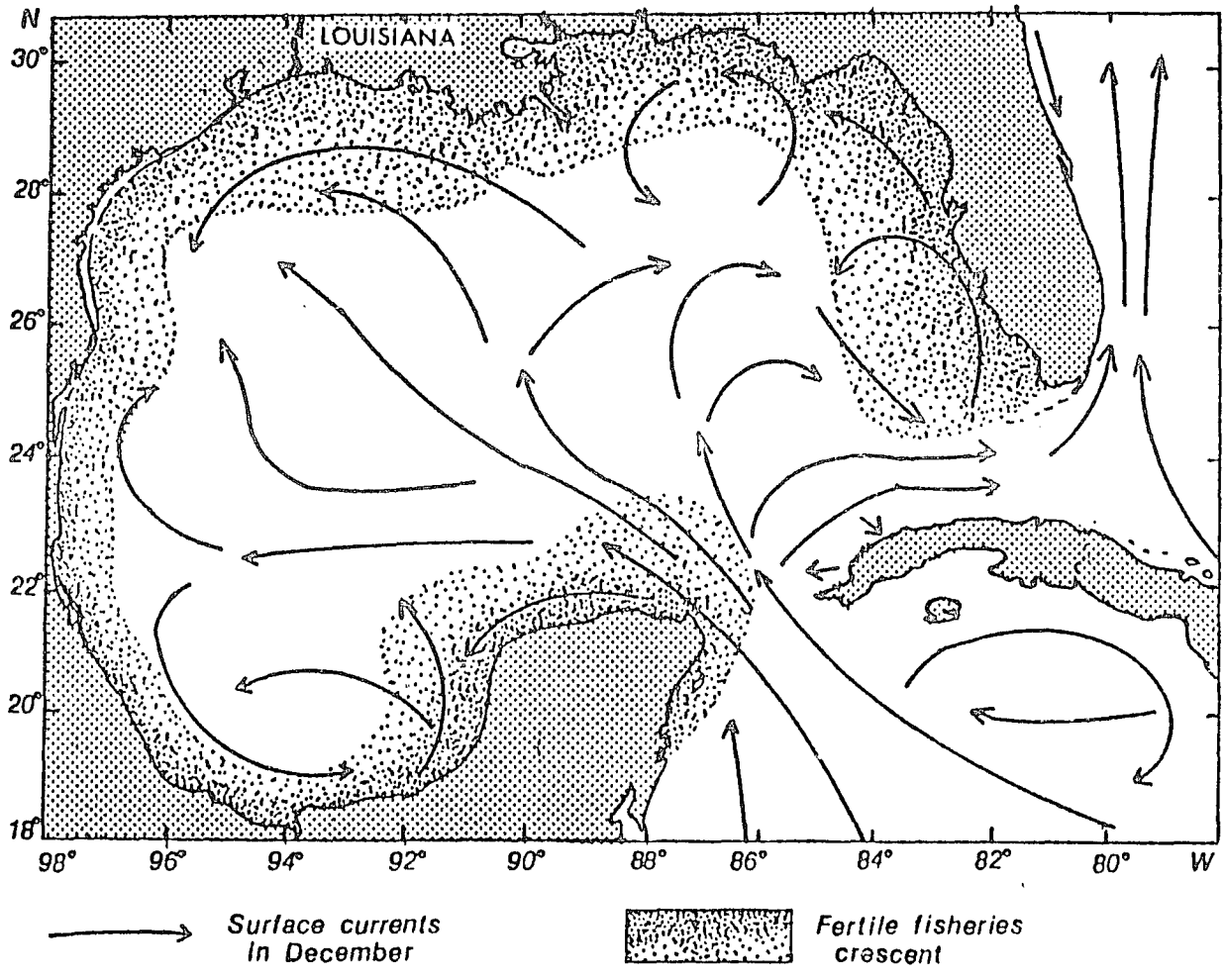



Fig. 1 Location of Louisiana with regard to the "fertile fisheries crescent" and movement of the Gulf's surface currents (Gunter, 1967; Hedgpeth, 1954; Leipper, 1954).

the nation in the quantity of reef gathered oysters, surpassed only by Maryland, Virginia and New Jersey (Taylor, 1897). In 1963, Louisiana became the nation's leading oyster producer (Matthiessen, 1970). Unlike the early years, between 70 and 80 percent of the 1963 production was canned or shipped to out of state processors, especially, those in Alabama, Mississippi and Virginia (Matthiessen, 1970). Also in contrast to earlier days when virtually all oysters were harvested from public reefs, the majority of these later oysters were products of commercially cultivated private beds (Matthiessen, 1970).

Part of the reason why Louisiana became one of the nation's leading oyster producers by the mid-20th century is that production in other areas diminished while Louisiana's increased to surpass other areas and then stabilized at a high level. Although the state's production remains high, it is believed that only a fraction of the potential production has been realized because of disorganization within the industry and "little emphasis on marketing techniques and quality control" (Matthiessen, 1970).

The consistantly high production of oysters in Louisiana, in spite of increased fishing pressures brought about by the rising demands from a nation-wide market, is largely attributable to the unique physical conditions present along the Gulf coast of Louisiana. Unlike other oyster producing areas in the United States, Louisiana has an exceedingly large coastal wetland area (approximately 14,000 square miles or 36,260 square kilometers) which exists in a state of dynamic equilibrium[1] (Gould and Morgan, 1962). The large expanses of wetlands interfaced by water bodies result in high rates of nutrient runoff from interior and adjacent wetlands which create highly productive estuarine environments (Day, et al, 1977). The areal extent and distribution of the land and fresh-water is constantly changing largely because of processes associated with the Mississippi River delta. These processes, involving alternate cycles of progradation and degradation of the Mississippi River delta lobes, have been active for at least the last 17,000 years as the river shifted its course numerous times. This has resulted in development of an extensive deltaic plain containing numerous estuarine embayments highly supportive of oyster communities. However, within these embayments the

[1]Note: Throughout this report words that are defined in the glossary will be referenced as Appendix 1.

condition and distribution of these communities are constantly altering in response to variations in major environmental parameters such as salinity, water currents, sedimentation, food availability, predation, competition, commensalism, and substrate. Several of these parameters which greatly influence oyster growth, reproduction and quality can be correlated with the stage of the delta cycle. Because the physical factors of the environment and the physiological requirements of oysters influence the areal extent, geographic distribution, and condition of the oyster communities, they determined to a large extent the early location of oyster gathering in Louisiana. Cultural factors, including the ability of certain ethnic groups to recognize and capitalize on oysters as an economic resource and the development of harvesting, transporting and marketing procedures for the commodity also influenced the location of the early oystering activities.

Methods of acquiring naturally growing oysters, cultivation of higher quality oysters, development of tools, and transporting and marketing techniques were accelerated in the mid to late 19th century as the demand for oysters grew. People living in the coastal zone realized they were capable of utilizing for economic gain a natural resource which in the past had been harvested primarily for food or as a supplemental source of income.

By the late 19th century, the oyster industry was active or at least present in much of the eastern half of coastal Louisiana. At this time conflicts arose among oystermen over the extraction of oysters and led to attempts to enact legislation aimed primarily at protecting the naturally occurring, renewable resource. Later, legislation was expanded to regulate the industry in order to promote its expansion. However,

the first comprehensive oyster law involving sound regulation provisions for harvesting and for protection of individual property rights so essential for promotion of the industry was not enacted until the turn of the 20th century in 1902. At this stage of development, the industry, which was already fairly well established throughout the eastern half of coastal Louisiana, was given a new impetus. Within a few years of the passage of this law, the number of privately owned and cultivated oyster grounds increased, thereby, taking some of the burden off the natural reefs which had previously supplied most of the marketable oysters. Louisiana was able to become the leading oyster producer in the United States in the latter part of the 20th century largely because of the naturally highly productive oyster growing environments in Louisiana, initiation of actively enforced legislation, and a state policy of enhancing natural reef production.

# CHAPTER II

## THE DISTRIBUTION OF OYSTERS ACCORDING TO THEIR PHYSIOLOGICAL REQUIREMENTS AND THE PHYSICAL ENVIRONMENT

Oysters are widely distributed around the world between latitudes 64°N and 44°S. They occupy estuarine environments having wide variations in such environmental parameters as temperature and salinity. However, in order to insure the probability of propagation, growth and high quality of oysters, certain criteria must be met concerning the character of the substrate, water movement, water salinity, water temperature and the type and availability of food. These parameters are sometimes referred to as positive environmental conditions (Galtsoff, 1964). Five other features that are considered to be negative and which should be minimized or eliminated in order to improve an oyster's environment are sedimentation, pollution, competition and commensalism, disease and predation (Galtsoff, 1964).[2]

An awareness of the biology and environmental requirements for successful oyster production is a prerequisite for the researcher seeking to understand the distribution of oysters within the physical environment and the subsequent location of an oyster industry dependent on this resource. While cultural traits associated with certain ethnic groups may have been instrumental in enabling them to recognize the potential of the oyster industry in Louisiana, the natural environment was directly influential in determining the original location of commercial harvesting activity because it influenced the distribution, quality, quantity and rate of replacement of oysters during the early to mid-19th

[2]Note: See Appendix 2 for a more detailed discussion of the biology and physiological requirements of oysters.

century. As the industry evolved and cultivation techniques were developed and improved, it became imperative that oystermen understand the factors influencing oyster distribution and growth in order to achieve a successful commercial enterprise.

## The Physiological Requirements of Oysters

While the oyster is poikilothermic and can survive temperatures ranging from almost 32°F (0°C) to over 90°F (32°C), temperatures nonetheless influence a number of oyster functions including feeding, water transport, respiration, gonad formation and spawning (Galtsoff, 1964). The ideal water temperature is between 77°F (25°C) and 79°F (26°C). Cilia action is maximum in this range and results in maximum water transport within the oyster and a consequent rapid intake of food. Below 70°F (21°C) and above 79°F (26°C) cilia movement declines. Between 41°F (5°C) and 45°F (8°C) it ceases, and the oyster enters a state resembling hibernation. Where water temperatures are near the 77°F (25°C) to 79°F (26°C) range for long periods, maximum growth occurs. It is also in this range that maximum reproduction occurs since high temperatures are associated with long spawning periods (Van Sickle, et al, 1976).

Coastal Louisiana, located along the northern Gulf of Mexico between 29° and 30° north latitude and 88.5° and 94° west longitude (Fig. 1), has a subtropical climate and a water temperature range which permits an almost year-round growing season favorable to oysters and their microscopic food source (phytoplankton, zooplankton, bacteria and organic detritus, Van Sickle, et al, 1976). During the summer, surface water temperatures average less than 90°F (32°C) while ranging between 80°F (26°C) and 100°F (38°C). Winter water temperatures average less

than 60°F (16°C) and range between 32°F (0°C) and 80°F (26°C) (Bernard and LeBlanc, 1965). Winter water temperatures are kept relatively high because warmer Gulf currents flow northward from the Equator (Fig. 1). Under these conditions freezing of surface waters in shallow bays is very rare, and thus the chance of oyster mortality from freezing is reduced.

Optimum growth is related not only to warm temperatures but also to a salinity range of 15 to 22.5 ppt (Chanley, 1957). However, because it is euryhaline, the oyster can survive a much wider salinity range of 5 to 40 ppt. It is also adapted to diurnal, seasonal, and annual fluctuations (Galtsoff, 1964). The range for natural growth and survival in Louisiana is 5 to 15 ppt (Galtsoff, 1964; St. Amant, 1964). Continual low salinity, below 6 ppt, impairs the reproductive capability since gametogenesis is inhibited (Butler, 1949), but short term flushing by very low salinity or fresh-waters can be quite beneficial. Flushing can kill oyster predators without harming oysters because they can close their shells and isolate themselves temporarily from unfavorable fresh water conditions.

The ideal substrate for oysters consists of hard rock or semihard mud, not soft mud or sand. A firm, cohesive bottom can support the weight of a growing oyster thereby preventing its emmersion in the mud. Water movement should consist of a steady, non-turbulent flow over the oysters in order to deliver food and oxygen and remove wastes. A steady current also increases the opportunity for fertilization of the eggs and for transport of larvae to a suitable place of attachment.

While these five conditions are desirable within the specified limits, the following five, sedimentation, disease, competition and commensalism (Appendix 1), predation and pollution (Appendix 1), should

be controlled or eliminated. Excessive sedimentation will not only smother adult oysters, but it will also foul setting surfaces (Appendix 1) eliminating the essential clean surfaces for spat (Appendix 1) attachment. Few, if any, living oysters are found in areas of active and extensive sedimentation, either natural or man-induced.

Diseases can be devastating to commercial oyster production and few advances have been made in treating them. Usually, they go undetected until the oyster population has suffered extensive mortalities which, at times, may reach almost 100 percent. In the case of some diseases, such as Labyinthromyxa marina, which devastates mostly older oysters during periods of high water temperatures and high salinities, the only defense against total loss is to harvest the oysters as soon as they are marketable.

Competition and commensalism can weaken oysters and render them incapable of surviving adverse environmental conditions (Galtsoff, 1964; Hofstetter, 1967). In addition, some competitors, such as mussels, render the oyster commercially unprofitable. In order to avoid severe competition, it is best to plant oysters in water of a salinity that the oysters will tolerate but which their competitors can not. For example, oysters tolerate higher salinities than do mussels. Oysters can also endure temporary fresh-water flooding which will kill their high salinity competitors such as the boring clam and boring sponge.

Predation can also be controlled to a limited extent by locating oysters in waters with a salinity unsuitable for predators. For example, the oyster does well in salinities ranging from 5 to 15 ppt, but its major predator along the Gulf coast, the drill, (Appendix 1) is immobilized by salinities less than 10 ppt (Galtsoff, 1964). Furthermore, oysters can

survive a week or two of fresh-water flooding while the drill can not. However, it should be noted that the ability of an oyster to survive flooding by fresh-water is influenced by the water's temperature and turbidity as well as the duration of flooding.

Under natural conditions, all oysters may be killed by a prolonged freshet (Appendix 1) entering into a bay or lagoon, but the area will be quickly repopulated by oyster larvae spawned in non-flooded environments and brought in by tidal currents (Galtsoff, 1964). Larger destructive predators such as the drill, will be slower to reoccupy the oyster communities, thereby, enabling the oysters to obtain a head start in re-establishing themselves.

While pollution has become a substantial problem for commercial oyster production in recent years, it did not appear as destructive to the 19th century Louisiana oyster industry according to early literature. In some cases pollution results from excess nutrient input into water bodies which creates algal blooms that replace the oysters'normal food supply. This condition results in poor or starving oysters since the organisms in the bloom may not be suitable for oyster consumption. Some types of pollution can kill oysters while other types render them unfit for human consumption. For these reasons, it is unusual to find thriving natural oyster communities in polluted areas, and even rarer to locate commercially planted ones.

## The Physical Environment of Coastal Louisiana

The oyster growing region of Louisiana differs from that in other parts of the United States in several respects. First, the total area of water bottoms capable of producing oysters at some time under suitable conditions is approximately 472,000 acres (Payne, 1918) and far

exceeds that of other major oyster producing states (Moore, 1897). Furthermore, the coastal zone averages from 20 to 40 miles wide (McGinnis, et al, 1972) and stretches for approximately 300 miles along the northern shore of the Gulf of Mexico (Emmer and Day, 1977). This broad expanse of coastal area provides a greater opportunity for a larger combination of suitable oyster parameters thereby increasing the chances for successful oyster growth in Louisiana.

Second, the 3,910,664[3] acres of marshland (Perret, et al, 1971) adjacent to or surrounding the actual and potential oyster growing bottoms constitute 41 percent of the salt marshes of the United States (Turner and Gosselink, 1975). These wetlands contribute heavily to the high rate of nutrient input into Louisiana's exceedingly productive estuarine environment (Day, et al, 1973). Third, Louisiana's position in a subtropical climatic zone permits an almost year-round growing season that enhances oyster seed production and growth (Galtsoff, 1964). The large area of potential oyster growth and the high rate of seed production combine to give Louisiana a higher potential for oyster production than exists elsewhere in the United States (Moore, 1897). Fourth, unlike other coastal areas, the Louisiana coastal zone is naturally more dynamic (Morgan, 1972) in that the amount, type and distribution of land and water is constantly changing largely in response to the interplay of an active prograding delta and the normal coastal erosional processes. Throughout Louisiana's recent geologic history these shifts in land and water areas and associated suitable oyster parameters have resulted in a

[3]Note: These figures represent recent measurements and can not be used to determine the amount and type of wetlands and water bodies present in the 19th century. It is known that the Federal government gave approximately 9,493,456 acres of wetlands including swamps to Louisiana for reclamation under the Swamp Land Acts of 1849, 1850, and 1860 (Shaw and Fredine, 1971).

natural shift in oyster production both with regard to spawning and growth. This manner of shifting oyster production also serves to distinguish Louisiana from other oyster growing areas in the United States.

In the mid-19th century, man began to increase his influence on coastal processes and landforms. By the late 20th century, man's activities have a substantial impact on the coastal environment including the ability of certain areas to produce marketable oysters. However, this study centers on the early stages of the development of the oyster industry and therefore primarily emphasizes the role of the natural physical environment in oyster spawning, growth and cultivation.

## Deltaic Processes

The actual and potential ability of any part of coastal Louisiana to produce oysters at a particular time is influenced by both present and past deltaic activity to the extent that this activity influences seven out of ten major parameters affecting natural oyster spawning and growth (See Appendix 2 for discussion of parameters). The Louisiana coastal zone is comprised of two major physiographic regions, the chenier plain and the deltaic plain (Fig. 2). The chenier plain constitutes approximately one third of the coastal zone of western Louisiana. It is an indirect product of Mississippi deltaic activity in that it consists of Recent river sediment that was transported by longshore Gulf currents from the eastern area of delta deposition. During the period when the Mississippi delta was prograding in a westerly direction, the mud flats prograded Gulfward as an abundant supply of sediment was swept westward. When the river shifted its course and prograded in an easterly direction, marine erosion reworked these sediments and created beach deposits parallel to the Gulf. This alternate depositional and

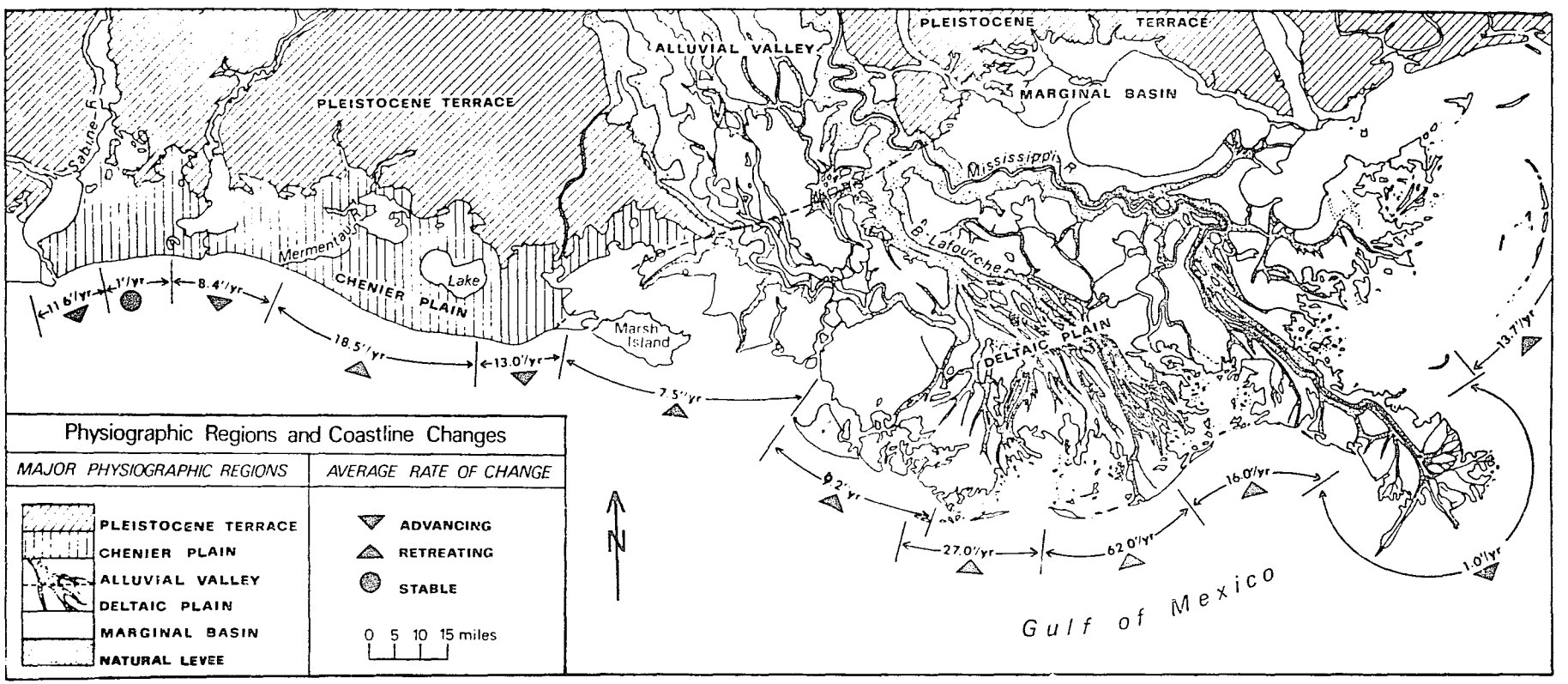



Fig. 2 Major physiographic regions in coastal Louisiana and average rates of coastline change (after Morgan, 1974; Morgan and Larimore, 1957; Gagliano and Van Beek, 1970).

erosional activity over the last few thousand years resulted in a fairly broad chenier plain characterized by cheniers (Appendix 1), coastal mud flats, broad marsh zones ranging from saline along the Gulf to fresh toward the interior, and numerous roundish lakes within these marsh zones (Bernard and LeBlanc, 1965).

The surface of the chenier plain region dips gradually toward the Gulf but the overland drainage is slowed by the cheniers lying prependicular to the drainage direction. While large lakes have formed behind some of these ridges, they do not have free exchange with the Gulf since longshore currents continue to block their river mouth openings with sediment constantly being eroded from the shorelines to the east. Prior to artificial dredging and maintenance of navigation channels and canals connecting the salty Gulf with interior fresher lakes in the late 19th and early 20th centuries, these water bodies were normally too fresh to support extensive natural reef communities. The majority of the natural reef communities were confined to the tidal channels located in the saline marshes adjacent to the Gulf of Mexico.

In general, environmental conditions in the eastern two thirds of Louisiana composed of the deltaic plain are more favorable for the development of viable oyster reef communities (Appendix 1). Primarily this is because of the extensive shallow estuarine embayments and firm substrates created by the deltaic processes. The deltaic plain emerged within the past 17,000 years during a period of gradual sea level rise associated with the melting of the last stage of Pleistocene glaciation (C.E.I., 1977). During this period the Mississippi River shifted its course several times maximizing its stream gradient to the sea (Fig. 3). Once sea level reached a still stand approximately 5,000 years B.P.

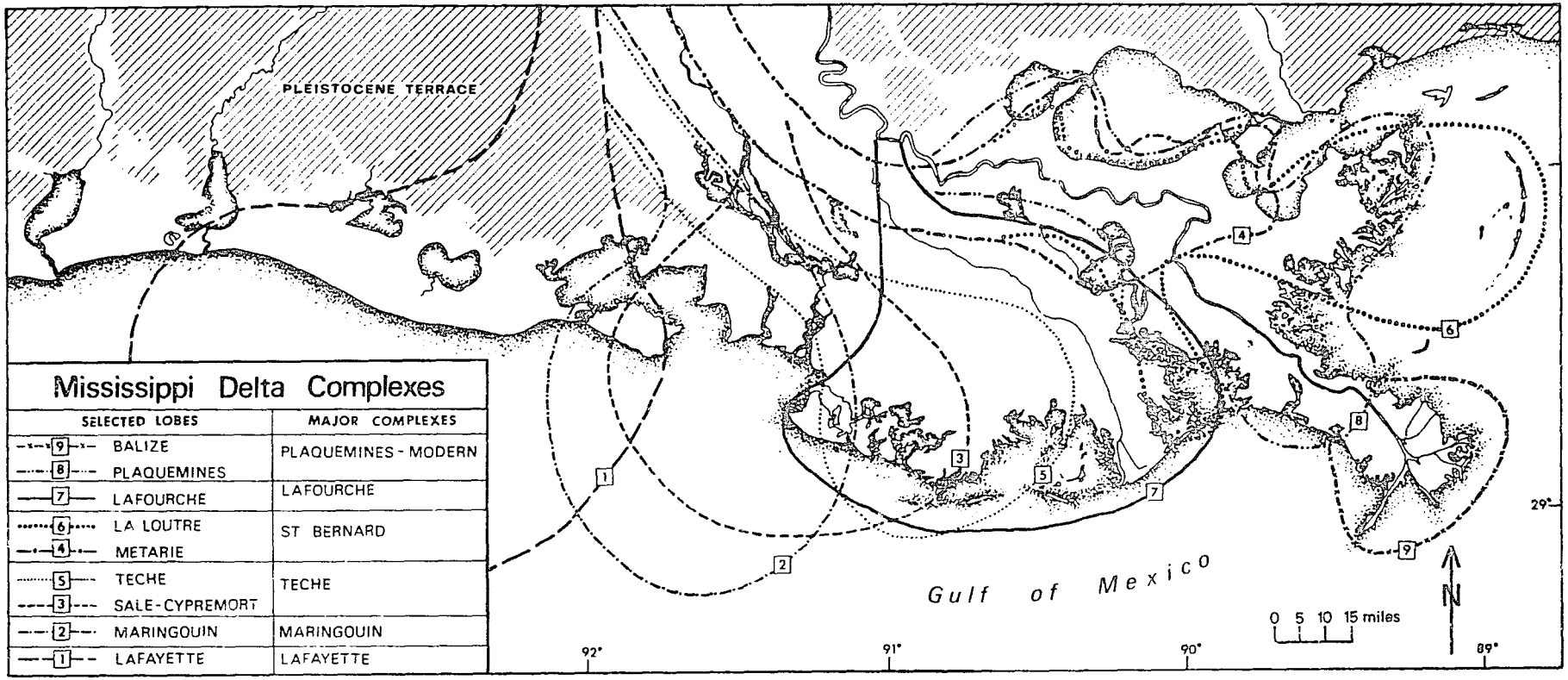



Fig. 3 Location of major Mississippi River Delta lobes during the last 12,000 years (after C.E.I., 1977).

(Saucier, 1963) the subareal portions of the deltaic plain emerged rapidly as the river shifted creating at least four major deltaic complexes (Fig. 3). The major physiographic units resulting from the deltaic activity are natural levee, inter-levee basins composed of swamps, marshes and water bodies, beaches and barrier islands (Welder, 1959; Bernard and LeBlanc, 1965).

## Changes in Coastal Physiography Related to Deltaic Activity

Analysis of the forms and processes associated with two recent Mississippi River Delta complexes, Lafourche and Plaquemines-Balize, illustrate how the coastal environment in a particular location changes in response to alternating progradational and degradational processes involved in active delta building (Fig. 4). A knowledge of these deltaic forms and processes and the physiological requirements of oysters helps to explain the continual shifting of viable oyster communities throughout the coastal zone in both an east-west and north-south direction.

Around 3,600 years B.P., the Mississippi River occupied what is now called Bayou Lafourche and developed a broad delta lobe characterized by extensive distributary channel-levee systems. Enormous amounts of sediment, transported via these channels onto the broad, shallow continental shelf, resulted in subaerial land formation or delta progradation and aggradation in southcentral Louisiana (Fig. 5a). The natural levees flanking the main and distributary channels are asymmetrical ridges having their highest point or crest near the channel (Fig. 5A). The slope between the channel and crest is steepest while that of the backslope is very gentle. These ridges form during periods of overbank flooding when sediment laden water leaving the channel loses velocity and

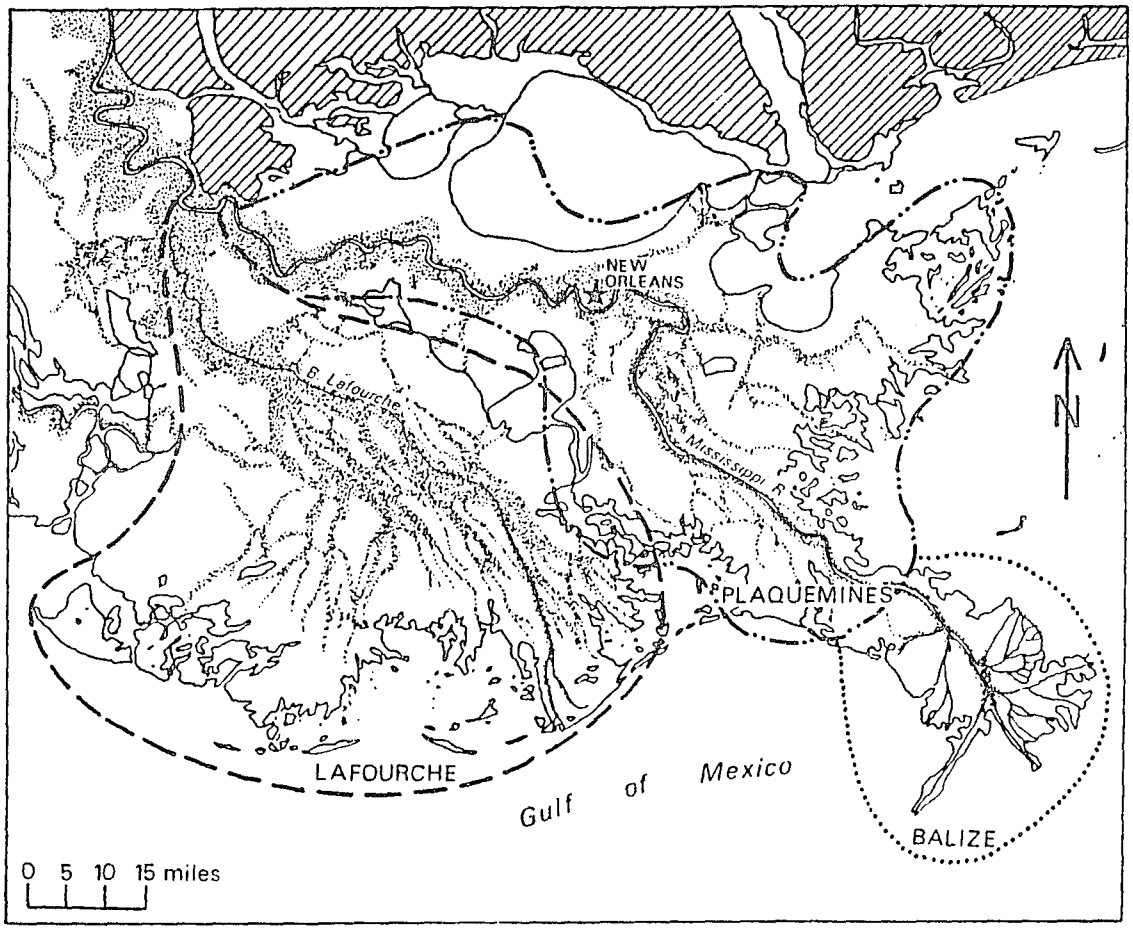
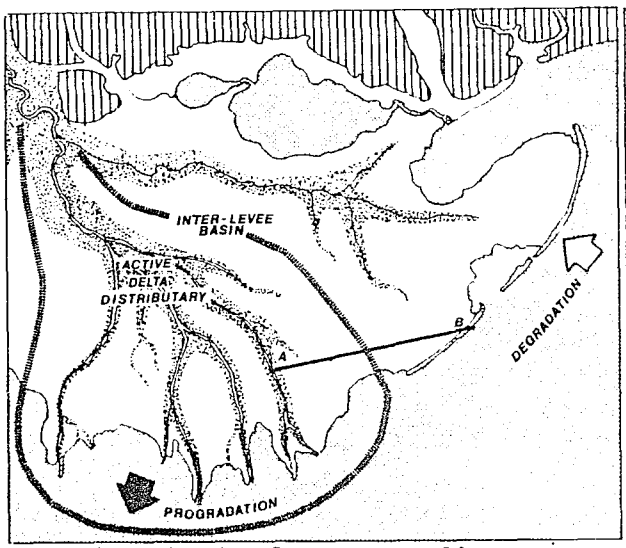
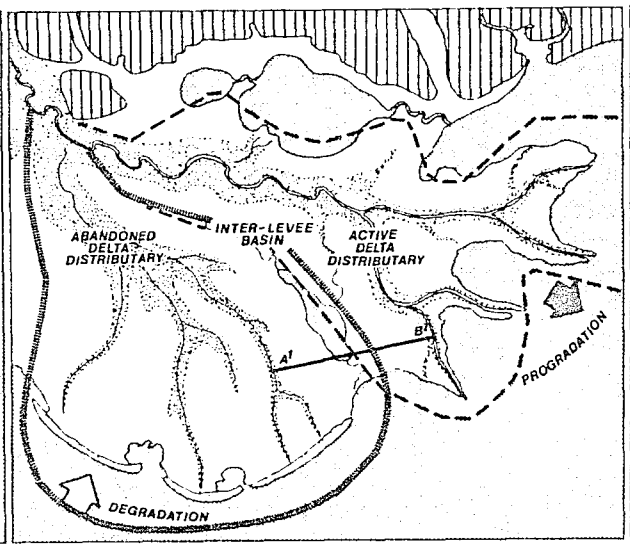



Fig. 4 Location and subaerial extent of two recent delta lobes, Lafourche and Plaquemines-Balize (after Gagliano and Van Beek, 1970; Frazier and Osanik, 1968).

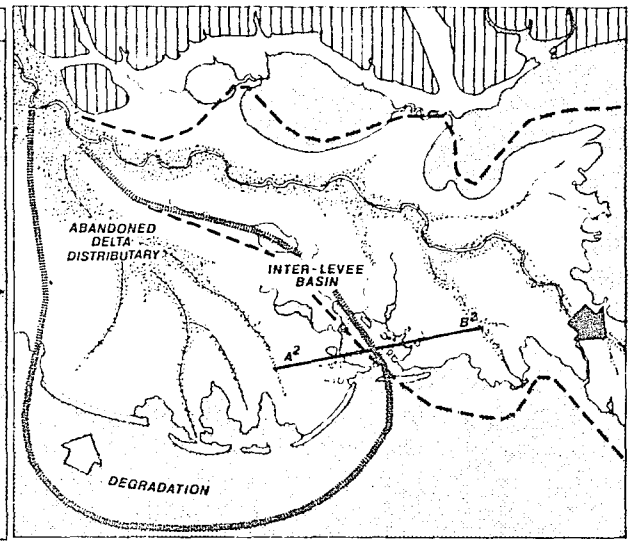
deposits some of its sediment near the channel. Because levees are elevated above the surrounding floodplain and are composed of firmer substrate they are ideal human habitation sites within the delta complex. During periods of delta abandonment, these areas are more resistant to erosion and remain elevated even when other areas of the abandoned delta lobe become flooded. Furthermore, these levees, once submerged by estuarine environments, provide firm substrate for oyster attachment and eventual reef establishment (Coleman, 1966).



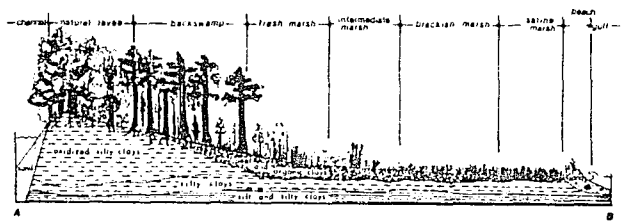

Areal extent of a prograding delta.



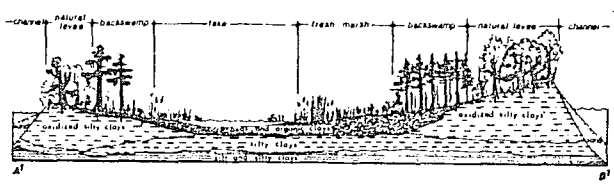

Areal extent of a prograding and an eroding delta.



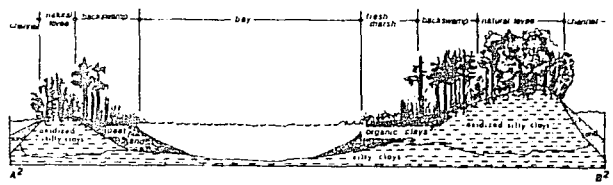

Areal extent of an abandoned delta and a well-advanced delta.



Environments of a mature, active delta.



Environments located between a prograding delta and one in the early stage of abandonment.



Environments within an eroding inter-levee basin.

-A- -B- -C-

Fig. 5 Alteration of the coastal environment in response to alternating progradational and degradational processes of an active, shifting Mississippi delta.

The large basins located between major levee systems of different delta lobes are known as inter-levee basins or delta flank depressions (Fig. 5a; Russell, et al, 1936; Bernard and LeBlanc, 1965). The smaller basins are found between distributary levees and are termed inter-distributary levee basins. The inter-levee basins are low-lying, relatively flat, featureless, poorly drained areas subject to flooding from overbank flow along the main and distributary channels. Unlike natural levees, they consist of finer silts and clays and have a high organic content making them less firm and more subject to compaction, subsidence and erosion (Fig. 5a). As long as overbank flooding occurs, water flowing into these depressions transports sufficient sediment to support vegetation and to offset compaction and subsidence.

Generally, vegetation in the basin consists of concentric, almost parallel, bands arranged from most elevated and freshest along the natural levees and upper basin to least elevated and saline near the Gulf (Fig. 5a). The highest regions of these basins along the natural levees are in the upper fresh-water reaches of the basin and contain extensive swamp communities commonly dominated by baldcypress and tupelogum. The flatter, lower lying, fresh-water regions with permanantly high water tables contain fresh-water marshes. The marsh vegetation grades into intermediate, brackish and finally saline communities toward the Gulf coast. Runoff from these extensive wetlands carries abundant organic and inorganic nutrients into the lower bays providing the basis for a highly productive estuarine environment.

When the Mississippi River changes course, as it did around 1,600 years B.P. when it abandoned the Lafourche course for the Plaquemines course (Figs. 4, 5b), there is a marked decrease in sediment input into

the inter-levee and inter-distributary levee basins associated with the abandoned delta front. Most of the sediment load is carried via the new channel and deposited at the new delta front resulting in shoreline progradation at that point (Fig. 5b). During flood stages water leaves the new channel and commences natural levee formation in the new delta lobe. While these same processes continue for awhile in the former delta complex, they are not as pronounced as before and gradually the impact of compaction, subsidence and marine erosional processes becomes more dominant along the abandoned delta front.

Once the new delta has prograded far enough seaward the inter-levee basin between the abandoned delta and the new delta continues to subside and collects swamp drainage and rain water (Fig. 5c ). Without the constant input of sediment from overbank flooding, these low lying areas become trapped depression lakes that continue to enlarge by subsidence due to compaction of sediments and downwarping of the prograding delta front and by shoreline erosion (Fig. 5c ). In time, the natural levees along the abandoned delta front (Fig. 5c) subside. Erosion and longshore transport of sediment at the former delta front create barrier islands which elongate in a parallel or sub-parallel direction to the mainland shore. Beaches develop in association with the barrier islands and longshore sediment transport. They, generally, consist of wave worked sediment, usually, of fine, well sorted sand and shell fragments. These are the smallest of the four major physiographic units within the deltaic plain.

Development of channels or tidal passes through these barrier islands and beaches permits saline Gulf waters to enter the subsiding inter-levee basins shoreward of the islands (Fig. 5c ). Even if some fresh-water continues to flow through the main abandoned delta channel, it can not

offset the effects of salt water intrusion which progresses inland in the absence of overbank flooding and sediment input into the inter-levee basin. Mixing of fresh-water draining from the upper basin and salt water from the Gulf creates estuarine conditions in the submerging inter-levee basins. As erosion progresses these basins become broad, shallow bays with numerous tidal channel connections to the Gulf.

Comparison of three maps covering the abandoned Lafourche delta complex shows the rapidity at which erosion can occur once the river has shifted its course and marine erosional processes and subsidence supplants the delta progradation processes (Fig. 6). For example, what originated as two separate inter-distributary basins between Bayous Petite Caillou, Terrebonne and Lafourche eroded into two bay complexes named Terrebonne and Timbalier. A hundred years later, the two bays merged as the Bayou Terrebonne delta complex eroded. As the bays enlarged, saltier Gulf waters intruded farther inland. In the process, oyster communities became established inland in lower salinity waters and ahead of the heavy predation associated with high salinity (Appendix 2).

## Relationship Between Viable Oyster Reefs and Phases Within the Delta Cycle

The environmental diversity and the biological productivity within a delta complex are related to the stages or phases of the delta's cycle (Fig. 7). An oyster community (Appendix 1) is a function of biological productivity and represents one type of natural environment within the larger Mississippi River Delta complex. The presence of a living reef correlates closely with certain phases of the delta cycle. They are present during the first stage of delta building (subaqueous growth) and during the latter part of the third and fourth stage (Fig. 7) when the

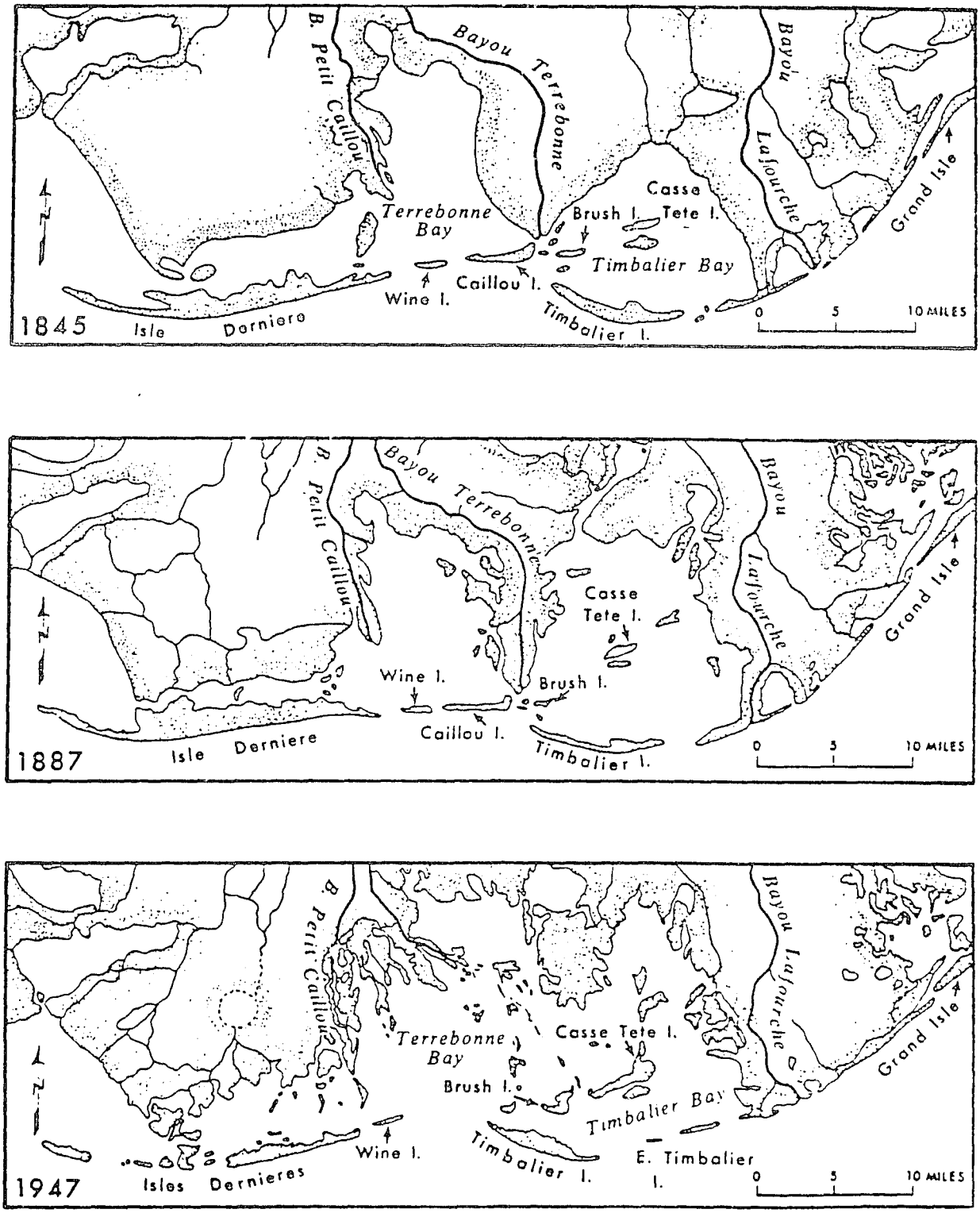



Fig. 6 Comparison of maps showing the rapid rate of erosion in the abandoned Lafourche delta complex (Kwon, 1969).

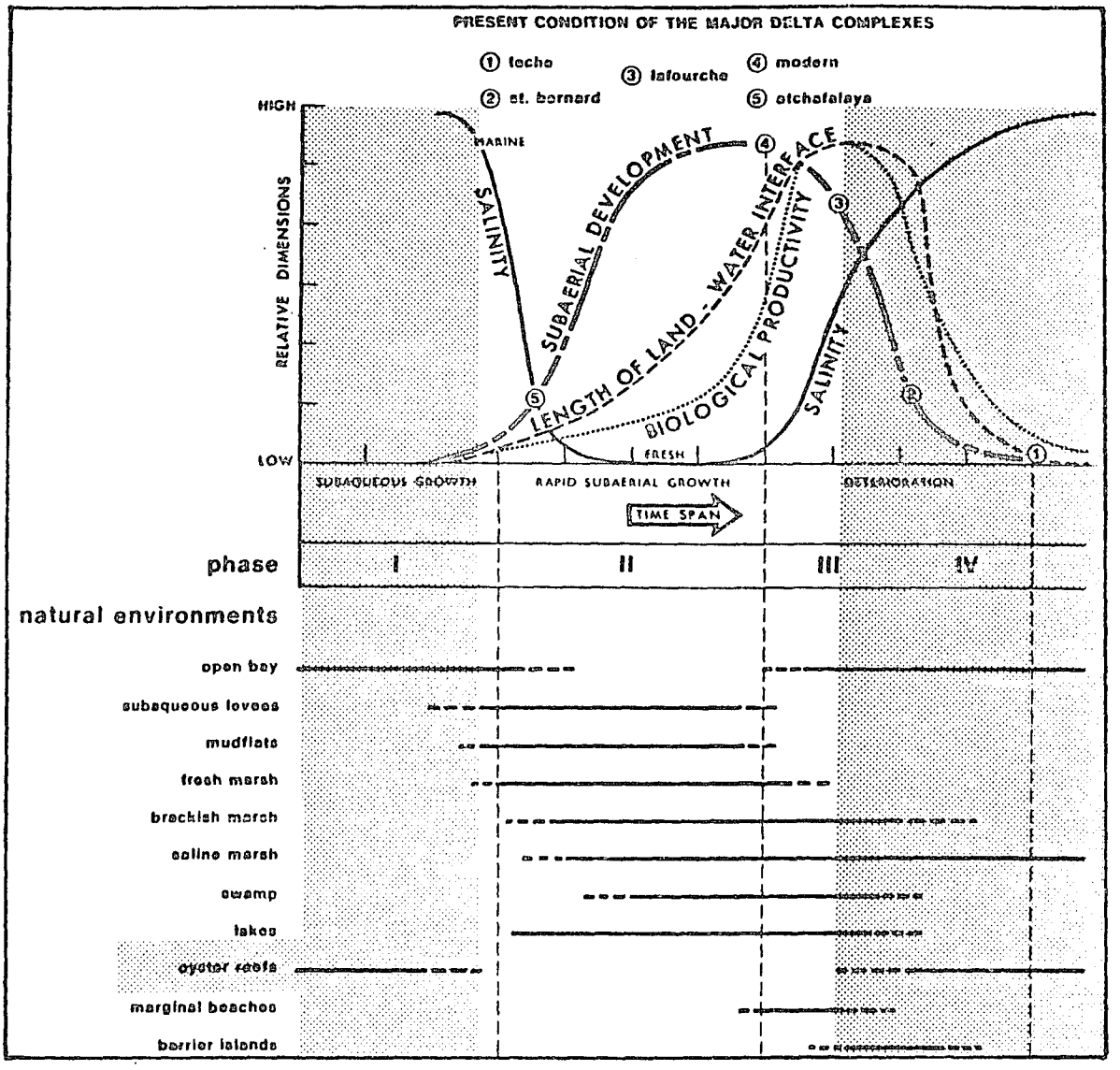



Fig. 7 A graph of environmental diversity and biological productivity as a function of the delta cycle. The relationship of oyster reefs to the cycle is designated (after Gagliano and Van Beek, 1975).

complex is deteriorating as a result of the shifting of the Mississippi River to a new channel. Living reefs are generally absent in the second phase of the cycle when rapid subaerial delta growth occurs. The absence of living oyster reefs in phase two can be attributed largely to the extremely low salinities resulting from the increase in the amount and duration of fresh-water discharge and the accelerated amounts and rate of sedimentation which create a soft or a sandy substrate.

The most productive oyster areas in Louisiana lie on the outer (seaward) fringes of the deltaic plain in the general location of former Mississippi River delta lobes (Fig. 3). During delta progradation, heavy sedimentation and extensive fresh-water discharge retard development of extensive oyster reefs in the vicinity of active progradation. However, in the inter-distributary bays adjacent to the delta, conditions are often ideal for oysters to establish themselves. The seasonal overflow from the river eradicates oyster predators and other pests living in the higher salinities of the Gulf and adjacent waters. The input of organic and inorganic nutrients from the floodwaters enhances phytoplankton productivity and creates abundant food for the oysters. The firmer, coarser sediment along the back of the main inter-distributary levees provides sufficient support for the rapidly growing oysters.

As the Mississippi River shifts course and the delta begins to deteriorate, the region of successful oyster community establishment also retreats inland trying to maintain itself in a brackish water environment. Subsiding natural levees of the relic delta provide a firm substrate for establishment of new oyster beds farther shoreward. In addition, old rangia clam beds confined to the fresher basin environments behind the active delta constitute ideal cultch (Appendix 1) material for oyster spat attachment (Mackin and Hopkins, 1962).

Throughout Louisiana's geologic history, the shoreline has undergone constant change and oyster communities have been forced to move in response to the change. As old communities die because of factors such as sedimentation, increased salinities and accompanying increases in competition and predation, or to too much fresh-water, the spawn of the dying communities are dispersed on the currents to seek out more favorable habitats.

## Influence of the Physical Environment on Types of Commercial Oysters in Louisiana

While the abundance of productive oyster communities will vary in an east-west direction along the coast and be largely determined by the presence or absence of an active delta, the commercial quality of oysters within any one part of the coastal zone can also vary in a north-south direction due to the predominance of processes or conditions associated with various stages of a particular delta cycle. These variations can combine to create different environmental habitats within the individual inter-levee bay systems which influence the quality and quantity of oysters with regard to commercial cultivation and harvesting and commercial non-cultivated harvesting. Salinity and associated factors involving predation, competition, commensalism and disease appear to have the most influence on the commercial quality of oysters because they determine to a large extent the spawning, success of setting (Appendix 1), growth, shape, fattening and flavoring of oysters in coastal Louisiana (Table 1). Variations in salinity in an estuary influence these six factors thereby resulting in four commercial categories of oysters: seed, raw shop, counter stock and steam cannery (Appendix 1)(Fig. 8). The type of substrate is also crucial to oyster production. However, this parameter can be inexpensively controlled to a satisfactory extent by cultivation techniques such as the planting of cultch material to artificially harden the bottom and create a suitable substrate for spat attachment.

Averaged over a year's time the salinity in a typical estuary will range from almost none in the fresh headwaters to saline at its junction with the Gulf of Mexico. This salinity gradation can be divided into four major zones of oyster growth according to the effect each region has on

Table 1

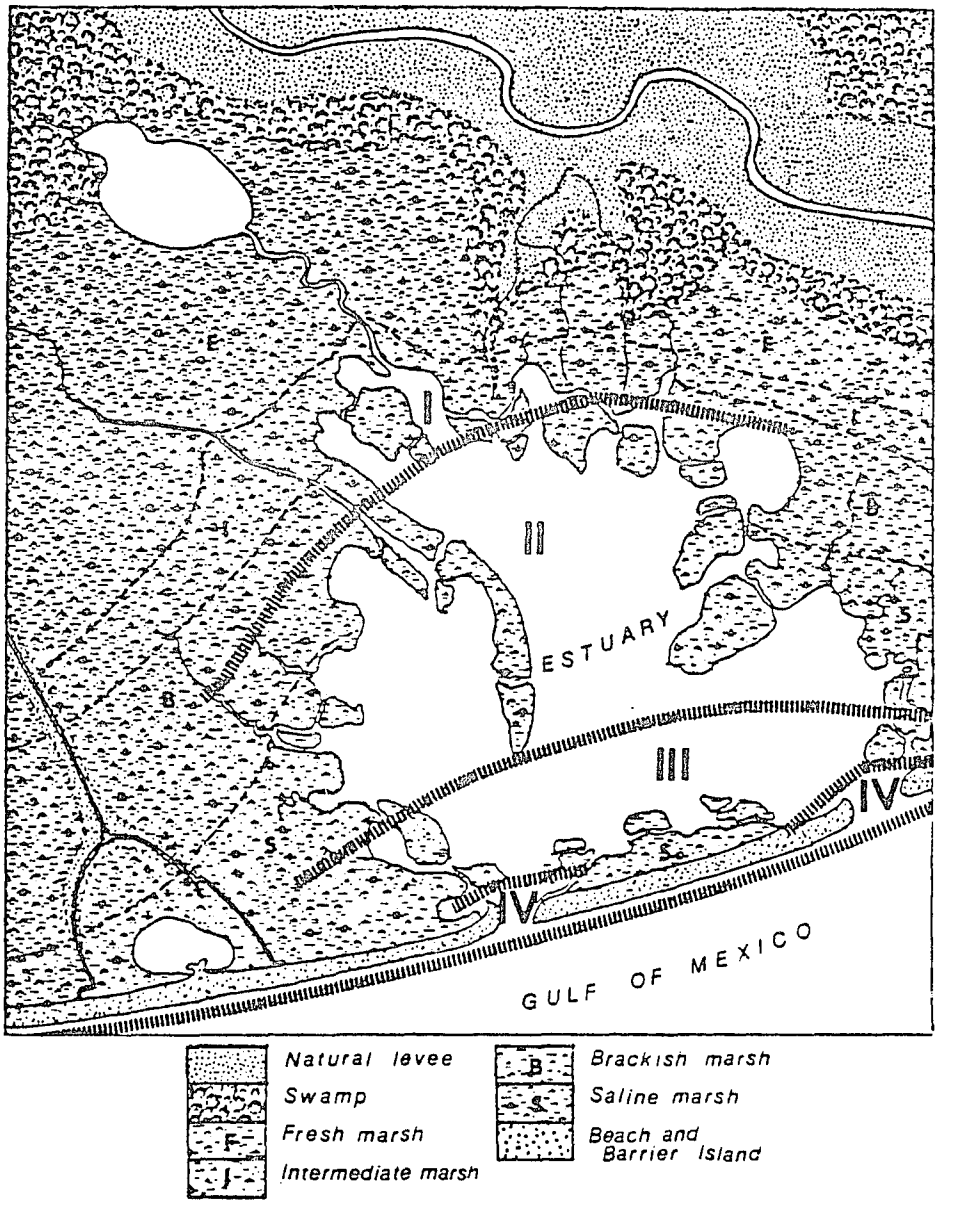
Relationship Between Location Within a Typical Gulf Coast Estuary, Variations in Environmental Parameters and Commercial Value of Oysters

| | VARIABLE PARAMETERS | ZONE I HEAD OF ESTUARY | ZONE II MIDDLE OF ESTUARY | ZONE III MOUTH OF ESTUARY | ZONE IV JUNCTURE OF ESTUARY & GULF |
|---|---|---|---|---|---|
| ENVIRONMENT | Salinity: | | | | |
| | Average | 10 ppt | 15 ppt | 25 ppt | 30-34 ppt |
| | Range | 0-10 ppt | 10-20 ppt | 10-12 ppt<br>30 ppt | 30-34 ppt |
| | Predators: | Few | Few | High | High |
| | Competitors: | Few | High | High | High |
| | Fouling Organisms | None | Few | High | High |
| | Disease: | Improbable | Possible | Probable | Most Probable |
| | Environmental Stability: | Marginal | Maximum | Maximum | Marginal |
| OYSTER COMMUNITY | Population Density: | Minimum | Maximum | Maximum | Minimum |
| | Reproductive Capacity: | Generally Low | High | High | Low |
| | Growth: | 1st Season: Good<br>2nd Season: Slow | Moderately Good | Unusually Good | Slow |
| | Avg. Annual Mortality: | High | Low | High | Excessive |
| | Cultch Availability: | Medium to Sparse | High | Medium | Sparse |
| POTENTIAL USE | Commercial Value: | Seed | Natural: Steam Cannery<br>Cultivated: Raw Shop | Cultivated: Counter Stock | Seed |

(Specific data from: Butler, 1954; Galtsoff, 1964; Bernard and LeBlanc, 1965; McConnell and Kavanagh, 1941).

Note: It is assumed that for the purpose of this comparison the following conditions are identical throughout the estuary:

1) Temperature: Winter Avg.=60°F
   Temperature: Summer Avg.=90°F
2) Food Availability: Adequate
3) Sedimentation: Minimum
4) Substrate: Firm Mud
5) Currents: Swift, Non-turbulent
6) Pollution: Minimum




| ZONE | LOCATION | SALINITY (ppt) | COMMERCIAL USE |
|---|---|---|---|
| I | Head of Estuary | 0-10 | Seed |
| II | Middle of Estuary | 10-20 | Steam Cannery, Raw Shop |
| III | Mouth of Estuary | 10-30 | Counter Stock |
| IV | Junction of Estuary and Gulf | 30-34 | Seed |

Fig. 8 Distribution of major commercial oyster types within a typical Gulf coast estuary. (Data from Butler, 1954).

oyster reproduction and growth. The extreme upper and lower regions (zones I and IV respectively) with either extremely low (0 to 10 ppt) or extremely high (30 to 34 ppt) salinities constitute marginal oyster growing environments where seed production is the more profitable use (Butler, 1954). In the upper estuary (zone I), salinity can range from 0 to 10 ppt, but the presence of prolonged fresh-water flooding due to drainage basin runoff can decimate the oyster communities. While predation and competition is low and fouling organisms are generally absent, the fresh-water environment retards reproductive capabilities and results in low population densities. Whereas growth may be good the first season, it becomes slow the second season. The average annual mortality is high because of the continuous subjection to fresh-water flooding. However, during periods of drought, salinity increases in the upper estuary and this area becomes an excellent location for spat attachment. This provides a seed source to compensate for the absence of the normal supply in the lower estuary (zone II or III) that failed due to excessively high salinities and heavy predation that accompanies these drought conditions.

The junction of the estuary with the Gulf is a marginal oyster producing area (zone IV) because of the consistantly high salinities. In this environment, the amount of predation, competition and fouling is high. During periods of high temperatures, disease is much more prevalent and often results in mass mortality. On the average, the annual mortality is excessive due to the combination of these four factors. Furthermore, growth is slow and oyster reproduction capacity is low. As in the fresh-water environment (zone I), this region becomes a valuable seed source during periods of natural disasters. After an excessive or prolonged period of flooding this area will be the first to experience an increase

in salinity. This allows spawning of oysters that survive the disaster, and provides enormous sets of spat which can be transplanted as seed the following spring. Mortality of this spat will be low the first season due to destruction of predators, competitors and fouling organisms by the prolonged flooding.

The area of maximum oyster productivity is located in the middle estuary (zone II). Here salinity averages 15 ppt and ranges from 10 to 20 ppt (Butler, 1954). While fouling organisms are common and competition can be high, predation is less frequent due to the seasonal flooding which depresses salinity low enough to be detrimental to major, high salinity related predators, especially the oyster drill. The population density in the middle estuary reaches a maximum because the reproductive capacity is high, growth is moderately good, predators are few and the average annual mortality is low.

Under these conditions, extensive oyster reefs develop quickly and oysters can become very clustered due to heavy sets of spat on the existing shell structures. Under natural conditions, oysters harvested from the environment are densely massed, poorly shaped and often thin. Their poor quality makes them suitable only for steam canning. However, if oyster clusters are broken apart or culled when still small and redeposited under a system of cultivation, they will quickly improve in shape and mass (Butler, 1954; Cary, 1907; McConnell and Kavanagh, 1941). As such, they can be marketed to the raw shop trade where they are individually shucked and sold raw for eating or for cooking.

The fourth zone containing the major commercial oyster category is located at the mouth of a typical estuary (zone III). In this location close to the Gulf, salinity is generally high (25 ppt) but can range from

a low of 10 to 12 ppt to a high of 30 ppt (Butler, 1954). This environment is less than optimum because, even though the reproduction capability is high and growth is usually good, the average annual mortality is high. This is because the number of predators, competitors and fouling organisms is high. Young oysters or spat are heavily preyed upon by predators and weakened by competitors and fouling organisms, thereby resulting in fewer oysters reaching maturity. However, this is an excellent location for cultivation of counter stock oysters, if they are transplanted to this site for a few months just prior to marketing (Cary, 1907; Gates, 1910; Pausina, 1970). At this stage of growth, their size makes them immune from many predators, such as the conch or crabs, and the bedding grounds (Appendix 1) can be fenced to keep out drum if necessary. Oysters spending their final months in this environment develop firm, fat, well flavored meats that are desirable for oysters served raw on the half shell in oyster bars or restaurants (Gates, 1910; Pausina, 1970).

In classifying each of these four major oyster growing regions, the average and the range of salinity rather than the location of the bottom within the estuary is the important criteria since salinity is a major influence on oyster development and its magnitude changes location through time. If other factors, such as sedimentation, pollution, substrate, food and currents, are satisfactory throughout the estuary, salinity levels become the major controlling factor in oyster growth and reproduction In addition to the physiological influence salinity has on an oyster's biological functions, it also guides other factors such as predation that influence an oyster's chance for survival and eventual reproduction (Table 1).

# CHAPTER III

## DISTRIBUTION AND CONDITION OF NATURAL OYSTER BOTTOMS IN LOUISIANA IN THE LATE 19TH AND EARLY 20TH CENTURIES

### Early Classification and Description Of Major Oyster Growing Bottoms

An accurate map showing the extent and condition of natural oyster bottoms in Louisiana was never made prior to man-made alterations of the natural environment and widespread harvesting of oysters. In fact, only one survey (Moore, 1898) was made in the 19th century. This was done on behalf of the Louisiana State Legislature which hoped to use the findings to formulate a comprehensive oyster policy for the state. Moore's survey included only one detailed map showing the distribution and condition of oyster reefs in the Louisiana Marsh (Fig. 9 ). However, during his survey assignment, he made brief stops along much of the remaining coast, making sample surveys and interviewing local fishermen regarding the extent and condition of natural oyster bottoms. Information obtained by these means was used to construct a map showing the condition of oyster bottoms in 1897 with regard to both specific and general reef conditions (Fig. 10).

The first map to show the distribution and condition of oyster bottoms in Louisiana was compiled by Payne in 1920 (Fig. 11). He divided the oyster bottoms into three major categories according to the area's ability to produce extensive reefs under natural conditions. They were described as highly productive, productive but requiring more fresh-water discharge and non-productive because of too little salt water mixing (Appendix 1). This characterization of Louisiana oyster bottoms is fairly accurate, but there are some errors and the map should not be seen as a portrayal of actual conditions in all instances. For example, all of Caillou Lake is shown as

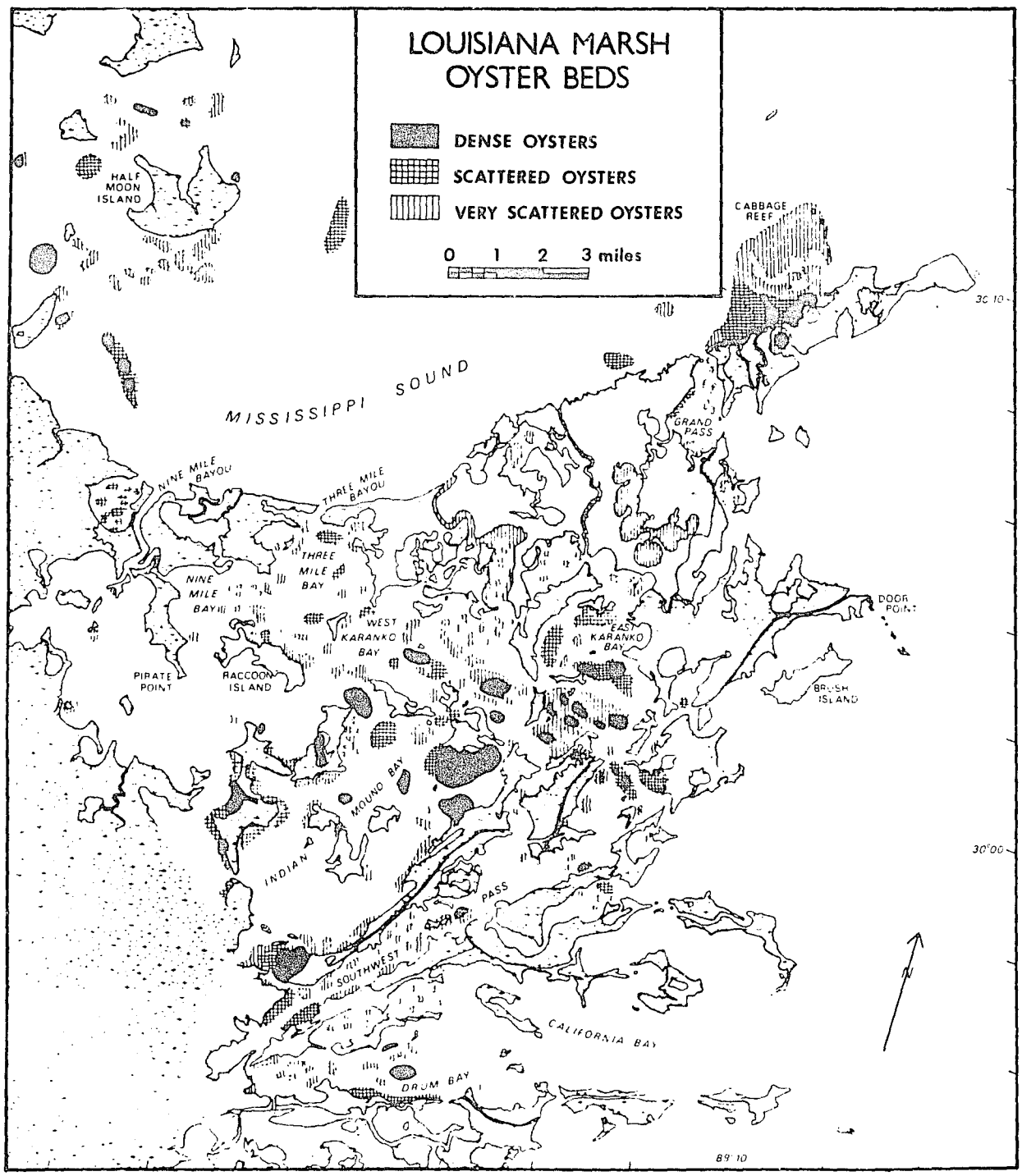



Fig. 9 Condition of natural oyster bottoms in the Louisiana Marsh in 1897 (redraft of map by Moore, 1898; see Appendix 1 for definitions).

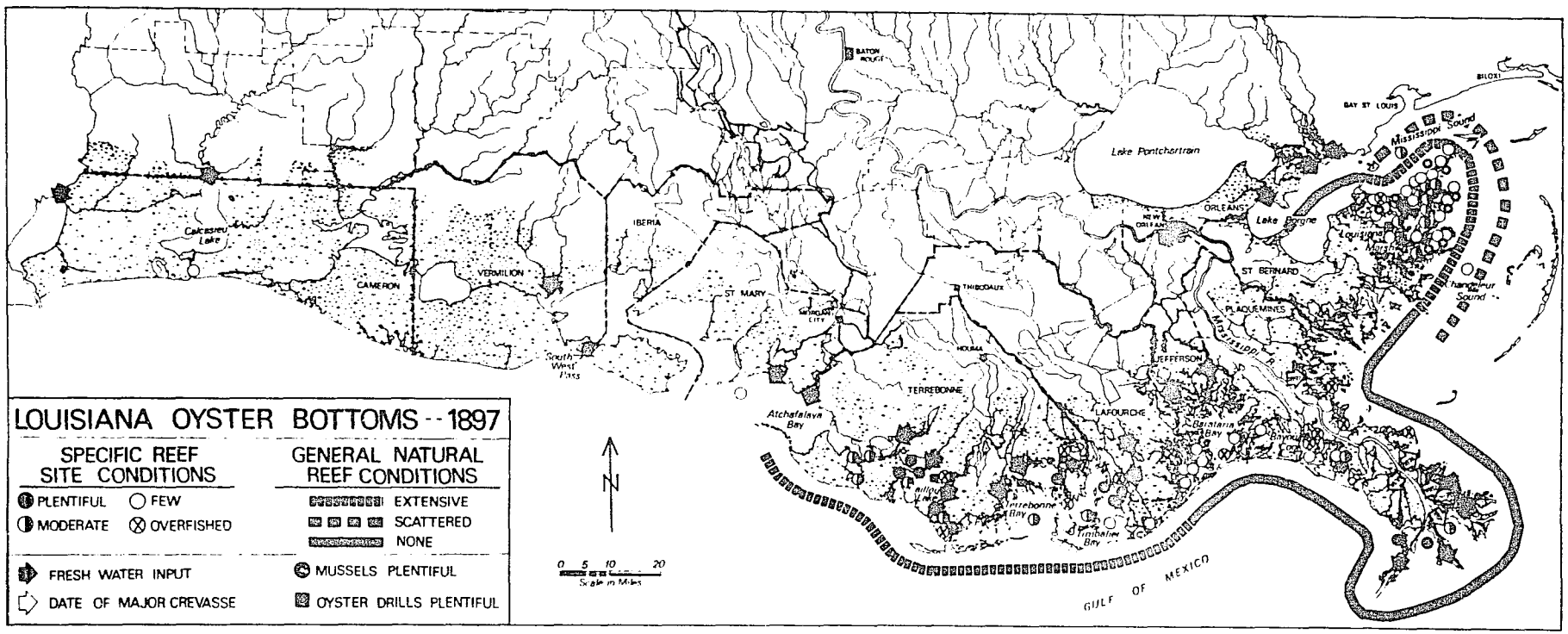



Fig. 10 Map of the extent and condition of Louisiana oyster bottoms in 1897 (compiled from information contained in Moore's 1897 survey of Louisiana's oyster bottoms).

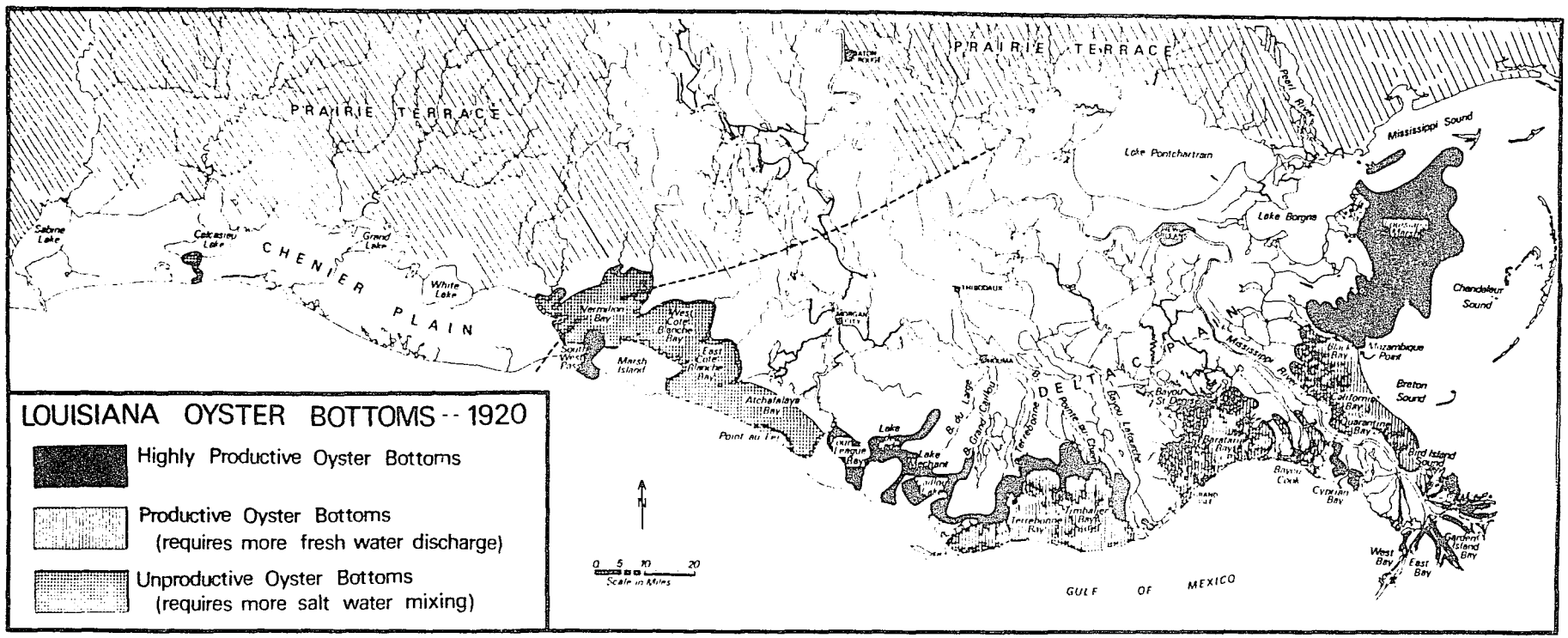



Fig. 11 Map of extent and condition of Louisiana oyster bottoms in 1920 (after Payne, 1920; see Appendix 1 for definitions).

highly productive, yet it is estimated that not more than a fourth of the area was ever productive (Mackin and Hopkins, 1962).

There is a fairly close correlation between the data presented by Moore in 1898 and Payne in 1920. While the information in Payne's survey is general, Moore's data is often quite specific. He presents more information concerning individual reef conditions, the quality of the natural environment in particular areas for oyster production, and the ethnic origins of oystermen in particular areas. Information presented in Moore's report was useful in analyzing the origin and later dispersal of the Louisiana osyter industry in that he noted the progression of reef extinction away from the Mississippi River and was able to relate this in many instances to overfishing or poor harvesting practices.

## Variations in the Quality of Oyster Bottoms in Coastal Louisiana

According to Payne's survey, the productive and highly productive oyster bottoms were located in estuaries formed in deteriorating inter-levee basins stretching from Four League Bay in Terrebonne Parish to the Louisiana Marsh (Appendix 1) in St. Bernard Parish. With the exception of a small area of highly productive reefs in South West Pass, Vermilion Parish, this oyster region covered the central and eastern half of coastal Louisiana lying withih the deltaic plain (Figs. 2, 11). The primary highly productive sites were located in : 1) the Louisiana Marsh, 2) protected inter-distributary bays at the mouth of the river, 3) bays and bayous in the vicinity of Cyprian Bay immediately west of the river, 4) the northern reaches of Timbalier and Terrebonne Bays, 5) the series of bays and bayous stretching from the western side of Terrebonne Bay through Caillou Lake, Lake Mechant,

Lake de Cade to Four League Bay and 6) South West Pass connecting Vermilion Bay with the Gulf of Mexico (Fig. 11, Payne, 1920). These six major areas were considered highly productive because environmental conditions were favorable enough to permit sufficient spawning and growth to maintain viable oyster communities under a rational system of oyster harvesting.

Four major areas that contained oysters in the late 19th and early 20th centuries but were not productive in terms of the amount of spat generated and community viability include: 1) the area immediately east of the Mississippi River, stretching from Black Bay to Grand Bay immediately north of Cubit's Gap Crevasse, 2) the middle and lower reaches of Barataria Bay, 3) the middle and lower reaches of Timbalier Bay and 4) the middle and lower reaches of Terrebonne Bay (Fig. 11; Payne, 1920).

The major non-productive oyster bottoms were located in the Vermilion to Atchafalaya Bay complex. Another smaller site occurred in the lower reaches of Calcasieu Lake and tidal channels between the lake and the Gulf. Both areas were normally too fresh to support prolific oyster production because of blockage of fresh-water behind the Point au Fer Oyster Reef in the case of the Vermilion-Atchafalaya Bay complex and to river mouth bars across the streams draining out of Lake Calcasieu.

Louisiana Marsh

The Louisiana Marsh, located along the eastern edge of St. Bernard Parish was, and still is, the most highly productive naturally occurring oyster region in Louisiana (Figs. 9, 11) . This area, described as a "low-lying archipelego of irregular islands separated from one another by shallow bays, muddy lagoons, and tortuous bayous"(Moore, 1898), is situated on the deteriorating delta lobes of the former St. Bernard-Mississippi River delta

complex (Fig. 3). A local writer (Louisiana State Museum Scrapebook [L.S. M.S.], 74A) describing this area noted that it:

> ...extends from the lower side of Lake Borgne to Quarantine Bay, and, as its name implies, is low sandy soil overgrown with great long rushes, and is composed of innumerable small islands lying, in most instances, within a few 100 feet of each other and separated by deep channels. Jutting out from the shallow water along side of shore and sometime extending far out into the channel are oyster reefs and here is where the oysters are caught.

In the 19th century, salinity ranged from virtually fresh-water year round in Lake Borgne north of the Marsh to highly saline year round in the eastern Mississippi and Chandeleur Sounds located on the Marsh's northeastern and southeastern perimeters. An early survey (Moore, 1898) found mussels in the interior bays of the marsh and drills around the Marsh's northeastern to eastern perimeter near the Sounds, thereby, indicating that salinity within the Marsh followed a gradient from low in the north and interior to high on the eastern fringes (Fig. 10). The interior and northern portions of the Marsh were periodically decimated by fresh-water flooding from Lake Pontchartrain and the Pearl River. However, a replenishment of the area resulted from spawn being washed in by tidal currents from the higher salinity regimes on the eastern perimeter and from oysters growing in salt water wedges of deeply scoured tidal channels. The major benefit of this fresh-water flushing was that predators were not able to become permanantly established to the detriment of subtidal oysters (Mackin and Hopkins, 1962).

The seasonal influx of fresh-water flooding from the Pearl River and Lake Pontchartrain as well as from the Mississippi River prior to artificial leveeing brought the necessary organic and inorganic nutrients so vital to the high rates of productivity in the warm, brackish waters of the Marsh's

interior bays and bayous. Tidal flushing via the numerous bayous and tidal channels provided the steady, non-turbulent flow of water necessary for bringing nutrients and oxygen to the rapidly growing oysters and for carrying away sediment and organic wastes.

The great abundance of oysters in the Marsh was as much a result of the lack of negative environmental factors as it was of the presence of positive ones (Galtsoff, 1964). Sedimentation was minimal in this area since no large sediment laden streams discharged directly into the Marsh. Sediment from the Mississippi River rarely reached the area because the river had shifted its course from the region (the St. Bernard Delta complex) around 1,000 years B.P. and most of the sediment was directed to the lower active delta through the present day Modern (Balize) channel. Furthermore, leveeing of the Mississippi River prevented bank overflow into most of the Marsh and crevasses were not common in the upper delta-marsh complex. Any sediment that was transported through the Marsh was trapped by marsh grasses and prevented from settling onto and smothering the oysters. Competition from other organisms such as mussels, barnacles, bryozoans, boring clams, worms and algae was present as noted by Moore (1898; Fig. 10) but apparently not considered a major nuisance in the late 19th century.

Some predation was noted due to drills along the saltier Marsh exterior, but the loss to these or to drum and crabs was not discussed as being of prime concern. Major losses due to disease, while possibly present, were not noted at the time, possibly because of the enormous amount of oysters still available for harvest. Pollution, either domestic or industrial, was also not mentioned as a problem in the Marsh. This can be attributed to the lack of habitation and development in the Marsh and to the low concentration of pollutants in the Mississippi River during the 19th century.

The extensive areas of protected water bodies throughout the Marsh provided numerous sites for oyster growth (Fig. 9 ). Early reports indicate that oysters from various locations in the Marsh and surrounding sounds constituted all three major categories of commercial oysters (i.e. raw, counter, cannery) marketed in Louisiana by the turn of the 20th century. Oysters that reached New Orleans entered through the Basin Canals, in back of the city, and were known as raccoon or basin oysters proper. These oysters were described as "small, poor and rather bitter in taste" having been caught on the higher salinity shell banks within the Mississippi Sound, Pass Marianne and St. Mary's Shoals opposite Bay St. Louis (L.S.M.S., 74A). They grew abundantly in tight clusters on the numerous shell reef formations in the sounds and along the marsh perimeter in intertidal zones. Despite the heavy predation, especially from drills, production was high because of the enormous quantities of spawn released and the readily available reef substrate (Moore, 1989). Because of the heavy strikes and dense clustering, these reef or coon oysters (Appendix 1) possessed an awkward shape and were difficult to cull. Sometimes a single clump, as large as half a barrel (Appendix 1), was taken from the reef and shipped to the cannery for fragmentation and steaming in order to extract the meats (U.S. Commission of Fish and Fisheries [U.S.C.F.&F.], 1887).

It was reported that at one time it was commonly believed to be useless to transplant these oysters because it was impossible to fatten them or to improve their taste (L.S.M.S., 74A). However, as cultivation practices were adapted in the latter part of the 19th century, oyster planters relied heavily on seed produced in the Louisiana Marsh for transplanting to private grounds located elsewhere in the Lower Mississippi River delta. This transplanted seed, when properly tended, developed into the high quality counter

stock served in New Orleans' restaurants and oyster saloons. There was no extensive planting undertaken in the Marsh in the late 19th century possibly because a large part of the water bottom was unsuitable in its natural state (Moore, 1898).

Even prior to extensive development of seed transplanting, some oysters from the Louisiana Marsh were transplanted in order to improve their flavor and fat content. Candidates for this operation were present in scattered patches in the interior Marsh on muddy bottoms at water depths of two to seven feet. Prior to transplanting usually to Saline Bay about seven miles above Cubit's Gap, these oysters were "long, large and somewhat slender, being virtually nothing but skin and salt water" (L.S.M.S., 74A). While they were sometimes transported directly to market for cooking purposes, temporary transplanting improved their quality and made them more desirable for the raw shop trade.

Some oysters from the Louisiana Marsh were of excellent counter stock quality and could compare favorably with cultivated oysters from Bayou Cook, considered the best in Louisiana and among the best in the world, (Bolinger, 1892). These oysters were located in the interior Marsh in large lagoons and lakes ranging from two to five feet deep. They were labeled lagoon oysters and were known for being "fat and well flavored though somewhat fresh in taste" (L.S.M.S., 74A). They were also "exceedingly large and are not found in large clusters as are the sea oysters, these being rarely three in a bunch" (L.S.M.S., 74A). Because of their size and flavor, they were shipped directly to market via sloops and luggers or on the Shell Beach Railroad. However, due to their scarcity, they did not constitute a large portion of the New Orleans market in the late 19th century.

The deeper waters around the Chandeleur Islands also contained large

numbers of oysters in the late 19th century. However, they were not commonly harvested because they were located too deep for the tongs in common use at the time (L.S.M.S., 74A).

East of the Mississippi River

The majority of the area south of the Louisiana Marsh between Mozambique Point and Bird Island Sound ceased to be highly productive oyster bottoms by the turn of the 20th century (Moore, 1898; Fig. 10). Natural erosion and artificial leveeing of the river had permitted year-round salt water intrusion into most of the expansive bay systems. Some fresh-water flowed into Quarantine Bay via the Bohemia Crevasse but silting diminished its effectiveness (Mackin and Hopkins, 1962). High salinity decreased natural reproduction and high salinity related predators such as the drill preyed heavily on the oysters that did strike. The open, shallow water bays allowed wind generated waves and currents to smother oysters with sand or mud or to toss them into ridges along the shore.

It is believed by state biologists that this area could be made productive once again if fresh-water was introduced on a seasonal basis like it was prior to artificial leveeing of the river (Payne, 1920). The reason for this was that extensive strikes occurred on the dead shells after a natural crevasse (Moore, 1898). Oysters that survived predation grew rapidly, becoming fat and well flavored early in the season (i.e. September and October)(Moore, 1898).

In general, the oysters from east of the river in the vicinity of the Louisiana Marsh and Mississippi Sound were of a small size and inferior quality largely because of the dense reef conditions under which they grew naturally. Most of these oysters supplied the steam cannery trade in New

Orleans and along the Mississippi coast. Some were sold to the raw shop trade for home cooking but all commanded a lower price than oysters harvested west of the river.

The Mouth of the Mississippi River

The mouth of the Mississippi River also contained productive oyster grounds around the turn of the 20th century. These were small in area and confined to the intertidal backslopes of natural levees of the major distributary passes (Fig. 11). Prior to the 1892 Pass a Loutre Crevasse, seed production in Garden Island Bay was fairly prolific. The small oysters were transplanted to Whale Bay northwest of Southwest Pass and supported a prosperous, but fairly small scale oyster enterprise based on the raw shop trade. However, the gradual filling of Garden Island Bay and erosion of the shoreline in East Bay and lower West Bay destroyed these scattered bottoms in the early 20th century (Moore, 1898; Lobrano, 1977).

West of the Mississippi River

Prior to the artificial leveeing of the Mississippi River, oysters also grew naturally in the interior bays and bayous immediately west of the river in the vicinity of Bayou Cook and Cyprian Bay. However, as saltier waters moved into the tidal channels, artificially dug oyster and fishing canals, it remained year-round without benefit of dilution from annual overbank flooding of the river. This resulted in unfavorable conditions for consistent oyster spawning (Moore, 1898). These areas, despite a decrease in natural productivity, remained ideal for transplanting seed and cultivating oysters either for the counter trade or raw shop market.

While it was commonly believed that high quality oysters could be "procurred from all the marshes and bayous nearly as far as Galveston,

Texas" (Ingersoll, 1889), certain areas were characterized by a particular class of oyster that, in some cases, underwent at least preliminary cultivation. The finest oysters came from Four Bayous, Lake Peliot and Bayous Fontenelle, Cyprian, Chalons and Cook. A slightly lower quality of oyster was produced in the Timbaliers, East Bay and the Great Lakes (Barataria Bay) (Ingersoll, 1889). These oysters commanded the highest price and constituted the majority of the raw shop and counter trade products reaching New Orleans through the French Market landings.

The Bayou Chalons oyster was described as being large, long and possessing a clean shell while those from Four Bayous were middling, round and firm. Oysters from Bayous Fontenelle and Cyprian were described as "small, hard, and round, and much perferred by connoisseurs" (Ingersoll, 1889). Oysters from Lake Peliot were preferred for frying because they were round, very fat, and salty with a hard eye. Oysters from Bayou Cook were legendary for their flavor and most went to retail counters in New Orleans. They commanded a price of from $2.50 to $4.00 per barrel in the 1880s (Ingersoll, 1889).

Oysters coming from the Timbalier grounds were clumped and long, while Salinas oysters were considered less rich in flavor than those of the highest quality. East Bay oysters were said to be of a "very good kind, with a light-colored shell and very white inside" and those from the Great Lakes were in demand because of their peculiar flavor. One account ranked the oysters from Grand Isle and Barataria Bay as being next to those from Bayou Cook in quality, but commanding about the same price as those from the Salinas (Salt Works Canal). In 1880 this amounted to $1.25 to $3.00 per barrel (Daily Picayune, 1881).

The only highly productive oyster communities in this area at the turn of the century were located in the vicinity of Cyprian Bay above the Jump Crevasse. Salinities in this area were probably depressed seasonally by spring flooding via the Jump. However, these beds were limited in extent and were being fished to the point of extinction by the late 19th century (Moore, 1898). Oysters growing here were apparently not as densely clumped as those in the Louisiana Marsh and could be culled and shipped directly to the raw shop markets. Some cultivation practices, probably limited to culling and temporary replanting for better growth and quality, were undertaken in this area around the end of the 19th century. Most of this planting was done by creoles and other natives of the lower delta (Moore, 1898).

Barataria Bay

While Moore (1898) noted several small productive reefs in the lower reaches of Barataria Bay at the turn of the century, Payne's later map (1920) indicated only one area of highly productive oyster bottoms in Bayou St. Denis (Fig. 11). Overfishing and removal of shell substrate had rendered this lower, formerly productive bay incapable of naturally replenishing oyster communities even though some spawn entered the area from the deeply scoured tidal channel communities that escaped harvesting (Moore, 1898).

By 1920, salt water intrusion into the lower deteriorating Barataria Bay inter-levee basin had created unfavorable environmental conditions for natural reproduction and growth. Payne (1920) indicated that the entire area could become highly productive once again if fresh-water were introduced into the basin on a seasonal basis resembling that which occurred prior to artificial leveeing of the Mississippi River.

Earlier, experiments by Moore and Pope (1910) showed that salinity

levels in the upper portions of the bay were favorable for creation of oyster communities, but the lack of naturally occurring, suitable substrate hindered establishment of these communities. Experiments in Bayou St. Denis indicated that in certain locations in the upper bay oysters could strike successfully if given suitable cultch material and a sufficiently stable bottom. However, historically the upper bay was not a productive oyster growing region. It became so only after the 1910 Federally sponsored planting experiments showed that with cultivation techniques the area could produce large quantities of oysters. The lower bay with its higher salinities remained suitable for fattening and flavoring of nearly marketable sized oysters and continued to supply the raw shop and in some instances the counter trade.

Timbalier and Terrebonne Bays

The former Mississippi-Lafourche delta complex underwent rapid deterioration in the 19th century (Morgan and Larimore, 1957; Fig. 2, 4). As the inter-levee basins eroded into open water bodies and overbank flooding was suppressed by efficient leveeing of the Mississippi River, salt water moved inland forcing the location of highly productive oyster bottoms to also advance inland. By the turn of the 20th century, the areas of highly productive oyster bottoms were located in the upper reaches of Timbalier and Terrebonne bays near the mouths of fresh-water drainage bayous such as Bayou Grand Caillou, Bayou Petit Caillou, Bayou Terrebonne and Bayou Pointe-au-Chien (Fig. 11). Prior to being cut off from Mississippi River discharge in 1906, Bayou Lafourche, east of Timbalier Bay, introduced noticable quantities of fresh-water into Timbalier Bay via cross-channel navigation canals. A noticable deterioration of the reproductive capabil-

ities of eastern Timbalier Bay was observed when this source of fresh-water was eliminated (Moore and Pope, 1910).

Remnants of former highly productive reefs remained in the lower bays but higher salinities, disease, predation, competition and commensalism, as well as heavy fishing pressures were effectively removing these reefs by the turn of the century (Fig. 10). Most of these reef oysters went to canneries, either in New Orleans, Houma, Thibodaux or Morgan City. Some culling and transplanting was performed in areas with firmer bottoms and on protected sides of islands in the middle to lower areas of the bays, but most planting of smaller seed was done in the upper reaches of the bays near stream discharges. Despite competition from mussels in these upper bays, these areas were suitable for planting because drills were not overly destructive in the late 19th century (Moore, 1898; Moore and Pope, 1910; Payne, 1920). Most of the planted oysters went to the raw shop for shucking and canning. Some were probably sold to the counter trade for eating, but they did not have the reputation or command as high a price as counter trade oysters grown around Bayou Cook (U.S.C.F.&F., 1887).

Terrebonne Bay to Four League Bay

The series of bays and bayous stretching from the western side of Terrebonne Bay through Caillou (Sister) Lake, Lake Mechant, Lade de Cade to Four League Bay was a highly productive oyster area during the late 19th and early 20th centuries (Fig. 11). Coastline retreat of the buffering marshlands was low (Fig. 2) in the region thereby allowing conditions in the interior protected water bodies to remain brackish and more stable. Reefs were able to become established along the firmer bayou and lake shorelines. The lakes served as mixing bowls where the saline Gulf waters, penetrating

through deep tidal channels, were diluted to brackish conditions by fresh-water entering via Bayous Mauvais Bois, du Large and Grand Caillou. During some flood years, fresh-water from the Atchafalaya River would flow eastward through Four League Bay and penetrate these coastal lakes and bayous. However, this flooding was of short duration during the 19th century.

South West Pass

The only other area of highly productive oyster bottoms in coastal Louisiana was located in South West Pass between Marsh Island and the mainland (Fig. 11). A strong tidal exchange in this area maintained brackish conditions in the Pass despite the fact that Gulf waters to the south were saline and Vermilion Bay waters ranged from almost fresh to brackish. The strong currents bathed the reef oysters with an abundance of food and oxygen and removed waste materials and sediment. If oysters in the Pass were killed by prolonged fresh-water flooding, the area would quickly rejuvenate from current borne spat swept in from the reefs along the south shore of Marsh Island. Intertidal reef structures were prominent in this area and provided a good source of seed for transplanting. Larger oysters taken from the reefs were probably shipped to canneries.

As the oyster industry moved westward from the Mississippi River during the latter half of the 19th century, many of these reefs were just beginning to be commercially harvested by the time those discovered earlier to the east had been fished to the point of commercial extinction. Also by this period, ideas concerning private ownership of oyster bottoms and cultivation to improve quality and quantity were becoming better established even among those persons without a previous history of oyster planting. At the end of the 19th century, it was stated that Terrebonne Parish, especially the area

between Four League Bay and Terrebonne Bay, possessed the "greatest and most productive oyster region in the State" yet few men were engaged in planting in the area (Moore, 1898). Rather, most oystermen harvested their catch from the extensive natural reefs.

Atchafalaya Bay to Vermilion Bay

The only extensive, potentially productive oyster bottoms in the coastal deltaic plain covered Vermilion, East and West Cote Blanche and Atchafalaya Bays (Fig. 11). Oyster bottoms in this area were classified by Payne (1920) as non-productive but capable of being improved "by removal of Point au Fer shell reef, permitting the outflow of the fresh-water of the Atchafalaya River." In this area, deterioration of one of the earliest delta complexes (Maringouin and Teche, Fig. 3) had been occurring for the longest period of time. By the 19th century, most of the delta complex south of the Teche Ridge had been eroded and an expansive bay system had become trapped between the interior fresh-water marshes and swamps flanking the Teche levee and the Gulfward Marsh Island and Point au Fer shell reef.

The island and reef complex acted as an effective barrier trapping fresh-water runoff and stream discharge and preventing effective mixing with the saltier Gulf waters. With increase in fresh-water discharge through the Atchafalaya River in the late 19th century, the area experienced more prolonged fresh-water flooding making it unsuited for oyster spawning and growth.

Calcasieu Lake

A similiar situation, but covering a less extensive area, existed at the juncture of Calcasieu Lake and the Gulf of Mexico about 75 miles west of Vermilion Bay (Figs. 10, 11). In both locations during dry seasons or periods of little fresh-water discharge, salinity would rise and an oyster

strike could occur. The spawn would be carried in by currents from oysters spawning on the reefs in the intertidal bayous south of Calcasieu Lake. However, this was not a viable community because the enclosed bays and lakes were normally flooded for a prolonged period of time. Therefore, the seed had to be moved to more stable brackish environments if the oysters were to have a chance to mature and be sold for shucking in the raw shop or cannery trade.

With dredging and maintenance of a ship channel into Calcasieu Lake in the early 20th century, brackish conditions emerged and the area became a productive oyster environment. A ship channel was also dredged through the Point au Fer reef in 1916, and for a time oyster growth in the interior bay systems was promoted by the mixing of fresh and salt waters. However, the steady increase of the Atchafalaya River's discharge and progradation of its delta effectively destroyed the utilization of this area for large scale oyster production and planting (Lay, 1977; Fairman, 1977).

# CHAPTER IV

# DEVELOPMENT OF THE OYSTER INDUSTRY IN LOUISIANA

## Harvesting From Natural Reefs

Oysters have always provided an abundant, dependable, and easily gathered source of food high in nutritive value to Louisiana's coastal inhabitants. Prehistoric and historic Indians and colonists were able to gather sufficient quantities of oysters from the extensive shallow estuarine embayments for immediate consumption, barter or sale without benefit of elaborate tools. Shell middens built by American Indians, some dating as far back as 2,000 years B.P. and containing a high to dominant percentage of oyster shells, indicate that oysters constituted a substantial portion of the coastal Indians' diet (Russell, et al, 1936; McIntire, 1958; Byrd, 1974).

The distribution of these ancient shell middens demonstrates a "definite affinity between the sites and the drainage systems of the deltaic plain" (McIntire, 1958; Fig. 2, 12). The three factors governing location of the middens were: 1) the presence of an older delta system with well developed levees, 2) a permanent fresh water supply, 3) an adequate food supply. These conditions are present during the initial period of delta abandonment. At this stage some fresh-water is still flowing through the distributary channels from the main channel or from the upper, interdistributary drainage basins. The natural levees are sufficiently elevated above sea level and most storm surges to provide suitable habitation sites for the coastal dwellers. In the interior, in slightly brackish basins between the natural levees, rangia clams grow abundantly, while on the Gulfward portions of the interdistributary basins,

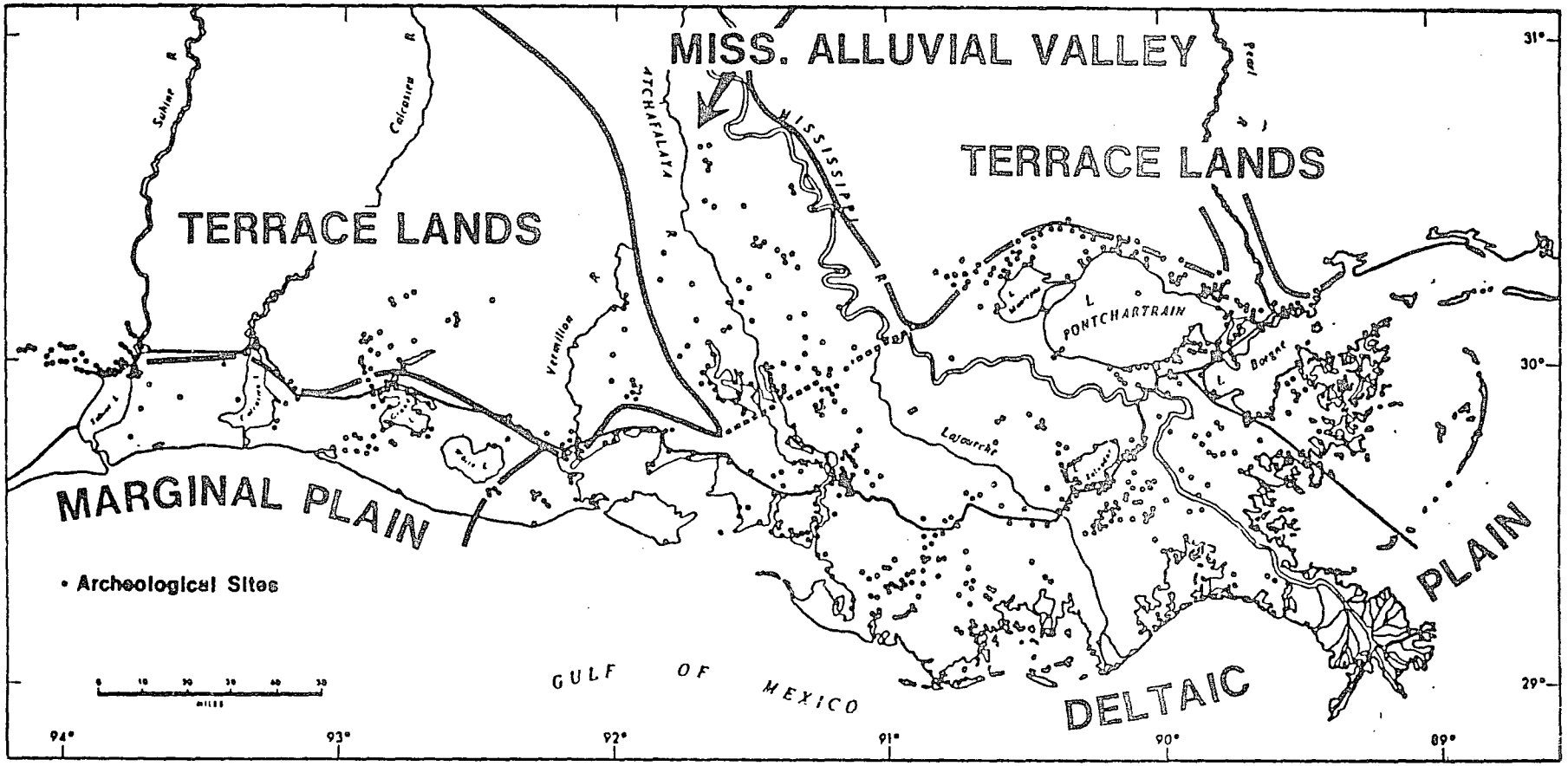



Fig. 12 Distribution of known archeological sites in coastal Louisiana (C.E.I., 1977)

oysters are the dominant mollusc. At some midden sites, the shell composition changed through time indicating that the aquatic environment was experiencing a salinity change. In cases where oysters supplanted rangia as the dominant shell type, it is evident that salinities were increasing as the abandoned lobe deteriorated (McIntire, 1958).

Prehistorically, coastal dwelling Indians had gathered oysters for food and possibly for barter by wading in the shallow waters and extracting single and small clumps of oysters by hand. By the early 19th century, Dyer (1917) reported that some Indians, especially the Atakapa, had devised crude tools to aid their simple gathering techniques. He noted that these Indians obtained oysters from salt water lagoons "...with rakes made of two strong poles, curved at the ends and interlaced with string vines..." (Dyer, 1917).

There is also some speculation that they carried on a limited trade in raw or smoked and dried oysters (Calver, 1920). However, this type of trade was probably not extensive for several reasons. First, transportation was a problem because the raw, unshucked oysters were heavy to carry and spoiled easily. The distance involved in reaching inland markets was a problem because the trip had to be made via canoe through numerous winding bayous. Finally, the cost or barter value of the final product, raw or dried, was probably worth more than inland Indians were usually willing to "pay" for food. Inland Indians were probably able to obtain sufficient food more cheaply and easily in their own surroundings and were not anxious to trade for "imported" oysters. Taken together, these three circumstances were sufficient to limit the extent of a commercial, though primitive, oyster based enterprise in pre-colonial times.

The simple oyster gathering practices of prehistoric Indians also

characterized the harvesting techniques of the early American and European settlers in coastal Louisiana. It is reported that early oystermen, engaged in selling oysters, also waded in the shallow water embayments extracting oysters by hand (Vujnovich, 1974). However, this primitive harvesting method was slow, tedious, often painful and not exceedingly profitable in terms of labor expended. Oysters growing in tight clusters in shallow waters have sharp jagged shells that can easily cut bare hands and unprotected feet. While some large, single oysters were probably gathered, most of the intertidal reef oysters were small, misshapen and tightly clustered around dead shells or other living oysters of varying sizes and ages. Therefore, because of their poor shape and overall low quality, they did not command very high prices nor did they justify a lot of expense to market them. However, when sold locally, they did bring some profit since little monetary expense was incurred in harvesting.

The only tools, if any, that were used in the gathering process, were gloves, a prying stick or hammer to break the clusters apart, and possibly a basket or container to hold the oysters during transfer to and from boats. Some early professional fishermen adapted long handled rakes to gather oysters in a pile under water for easy loading into a skiff or basket (Vujnovich, 1974).

With the influx of European immigrants in the 18th and early 19th centuries, conditions for the development of a commercial oyster industry in Louisiana improved. During the formative years, both the harvesting and marketing aspects of the oyster industry were concentrated within a short radius of New Orleans, a thriving port city on a major transportation corridor, the Mississippi River. Some reasons behind this initial location of the industry were:

1) an abundant supply of easily harvested oysters,

2) a dependable and cheap transportation route to market,

3) a market for oysters at plantations along the river,

4) a market for oysters in eating establishments in New Orleans due to the presence of European and American settlers with a taste for oysters,

5) merchants willing to grubstake pioneering oyster fishermen in return for a dependable source of oysters,

6) a willing and able work force filtering through the port of New Orleans to the lower delta to harvest oysters (Zacharie, 1897; Ingersoll, 1889; Vujnovich, 1974).

There is evidence that, as early as the beginning of the 19th century oyster peddlers had become very aggressive and vocal in selling their wares on the streets of New Orleans. It seems that these early oyster dealers placed themselves at street corners and seranaded the town from morning until night by blowing on conch shells to advertise that they had oysters for sale (Louisiana Gazette, 1805). Other early newspapers carried advertisements for oyster saloons or eating establishments (Louisiana Gazette, 1814; Plaquemines Protector, 1887a, 1887b). Statistics and detailed descriptions of oyster gathering and selling are very sparce for this time period. However, the newspaper advertisements, articles and letters to the editor are sufficient to indicate that some trade in oysters was occurring in the city of New Orleans. The extent of this trade was probably limited largely to the metropolitan area because of the relatively small population and consequent demand for oysters along the central Gulf coast (Ingersoll, 1889; Kellogg, 1910).

During the early 19th century, oystering was probably not a major occupation since it is unlikely that a person could make enough money

during the oyster gathering season (the colder winter months) to support himself or a family the remainder of the year. However, as the market demand increased, more fishermen were able to enter the business, sometimes as a larger scale enterprise or in a more diversified manner. In the second half of the 19th century, the oyster industry expanded to become a viable part of Louisiana's economy. What had begun as a simple gathering process to meet local demands expanded to the point where, at the turn of the 20th century, it ranked third in the nation in terms of the amount of oysters harvested. Most oysters were gathered during this period within a 10 to 30 mile radius of New Orleans and virtually all went to meet the needs of that city and nearby plantations (Dennett, 1883).

### Expansion of the Industry through Cultivation

The simple gathering process which characterized the early efforts at oyster harvesting for subsistence or sale underwent modifications but persisted into the 20th century as a basic method of the oyster industry. The adaptation of oyster cultivation practices, in addition to simple gathering techniques, probably began in Louisiana in the mid-19th century. Oyster cultivation is distinguished from the earlier methods of oyster acquisition in that it is "a method by means of which the number of oysters are increased by artificial means above that produced under natural conditions" (Kellogg, 1910).

The primary reason for implementation of various methods of cultivation in Louisiana was probably comparable to that of other oyster producing areas in the eastern United States and Europe, ie. the need to sustain a a source of marketable oysters equal to or greater than that which the natural environment could provide under heavy fishing pressure. In the

early 19th century, oystering was undertaken without regard for preserving the reefs as naturally renewable resources and they were quickly depleted beyond the point of natural rejuvenation. In many cases, the extinct reef areas remained excellent growth and fattening grounds even after the natural reef community was removed. Therefore, cultivation was a practical alternative to maintaining an oyster industry in the lower Mississippi River delta near major markets.

A secondary aspect of cultivation was to improve the quality of oysters in order to increase their market value. Some major differences in the development of the oyster industry in Louisiana as compared to other regions of the United States include the early methods of cultivation, the persons most closely associated with the development of the industry and the unique environmental setting afforded by the presence of the Mississippi River delta.

## Initial Cultivation Sites and Variations in Practices

The actual method of cultivation varied slightly in different locations depending upon the oystermen's background and the period in which the cultivation occurred. There is some discrepancy in the literature regarding the first site used for cultivation. The credit for initiating oyster planting in Louisiana is sometimes given to Louis Esponger who planted oyster seed in Whale Bay around 1885 (Mackin and Hopkins, 1962). Other writers credit Luke Jurisich, a Slavonian (Appendix 1), with beginning the modern oyster industry because he was cultivating oysters in Bayou Cook during the Civil War, approximately twenty years before Esponger planted grounds in Whale Bay (Bilich, 1931). Another site mentioned in the literature as an early planting area was Grand Bay

(Oyster Bay) just off the Salt Works Canal east of the Mississippi River (U.S.C.F.&F., 1887; Moore, 1898; L.S.M.S., 74A; Dennett, 1883).

Whale Bay

While the exact location of the first oyster cultivation experience in Louisiana will probably remain open to controversy, all evidence seems to support the belief that the initial cultivation sites were in the Lower Mississippi River delta in the same general vicinity as the early commercial gathering activities. The discrepancy in crediting any of these sites, especially Bayou Cook verses Whale Bay, may lie with differences in interpretation of the term cultivation. For example, Moore (1898) is usually cited as the person giving Esponger credit for pioneering cultivation in Louisiana (Mackin and Hopkins, 1962). In actuality, Moore (1898) was referring only to cultivation practices in Whale Bay and Grand Pass when he reported that:

> Oyster planting began here about 1885, the pioneer and most successful operator being Louis Esponger, who in that year began to transplant oysters from the natural beds in Garden Island Bay, between South Pass and Southeast Pass.

The one aspect of the operation in Whale Bay that especially appealed to Moore was the reliance on cultch to attract young oysters. In his opinion, this was a higher or truer form of cultivation because it increased the amount of oysters available and put less pressure on the natural reef production. In commending Esponger Moore (1898) further stated that:

> ...he appears to have been the first man to appreciate the importance of planting cultch to catch the spat, and carefully collected oyster shells, and other suitable materials for the purpose, even, it is stated,

stipulating the return of shells when he sold his oysters unopened to the residents of Port Eads.

Esponger began his planting efforts in 1885 but it was probably not until 1892 that he put most of his efforts into planting cultch instead of seed. Prior to 1892, there was a sufficient supply of seed oysters available from Garden Island Bay, a short distance by boat to the east. In 1892, the Pass a Loutre Crevasse broke through the ditch in the natural levee and the resultant long term crevasse splay filled much of the bay, destroying the oysters. However, before they were completely submerged by sediment, many of the shells were removed to Whale Bay for cultch because strikes were fairly common in the area. This process was easier than acquiring seed from elsewhere which would have required a long journey either to Timbalier Bay to the west or to Bird Island Sound to the east. Therefore, the availability of cultch material, the destruction of the only nearby seed supply and the prohibitive cost of transplanting from Timbalier or Bird Island Sound encouraged Esponger and others in the area, who followed his example, to place heavy emphasis on the use of cultch material by the end of the 19th century.

Another incentive for planting cultch came from the fact that many of the oysters harvested in the area were consumed locally at Port Eads or were shucked locally and canned (packaged in milk cans and covered with ice) for shipment to New Orleans and points north and west (Lobrano, 1977). The piles of shells were rather cheaply transferred from the shucking sites such as Oysterville, about nine miles north of Port Eads, to the planting grounds (Lobrano, 1977). They did not have to pass through locks or shoal channels or be hand carried across levees to reach the bedding grounds as would have been the case for similiar activities in the vicinity of Bayou

Cook.

Bayou Cook

Moore (1898) however, does not give the impression that Esponger was the first oyster planter for in the same report he mentions that:

> The most extensive planting-grounds in Louisiana are the series of lakes, bays and bayous lying between Bay Jaque and Bastian Bay (Bayou Cook and vicinity) a large part of the best oysters found in the markets of New Orleans coming from this region.

At the time of Moore's survey, approximately 500 men were oystering in the Bayou Cook region in contrast to the five or six men working private grounds around Whale Bay (Moore, 1898). By the shear size of the oyster operations in Bayou Cook and the widespread reputation of its high quality oysters, it would appear that that oyster enterprise had been in effect longer than the one at Whale Bay.

One major contrast in the cultivation techniques practiced at Bayou Cook and Whale Bay was that the Bayou Cook planters relied on increasing the natural oyster supply by importing seed oysters culled from larger clumps of reef oysters spawned outside the area. The planting of cultch to attract spat was never a major component of oyster cultivation here as it was in Whale Bay in the late 19th century largely because of environmental conditions. For one thing, there were no major concentrations of shell or other material in the area that could be easily utilized as cultch material. The shells of oysters marketed in New Orleans were not returned to the private oyster grounds because of the expense in transporting them. Dead oyster shells were commonly utilized by the Slavonians in the vicinity of Bayou Cook to improve their campsite (Fig.13) rather than to improve their bedding grounds (Vujnovich, 1974). Since shell would have to be

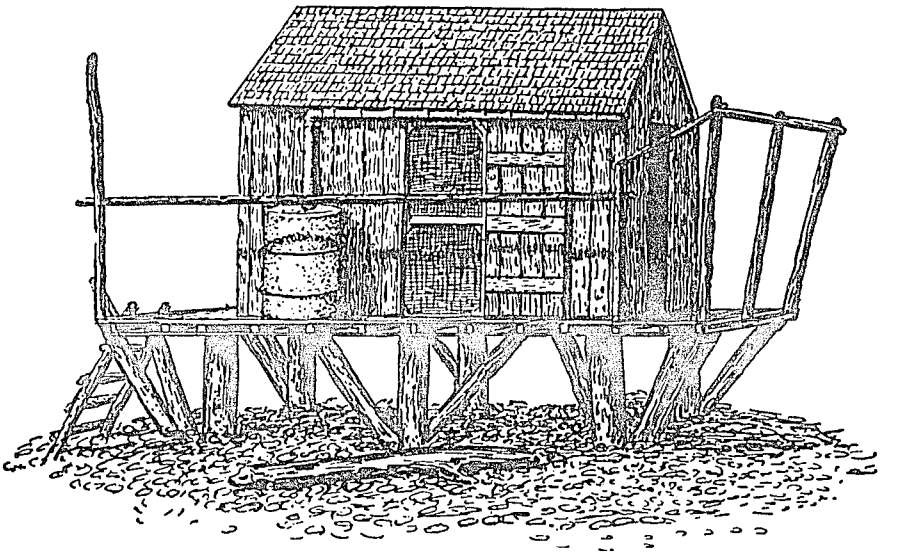


Fig. 13 Oyster shells around the base of a typical oysterman's camp in the Louisiana marshes (drawing from Kniffen, 1962).

imported, it was just as easy to bring in seed oysters instead, especially, since they had the added advantage of reaching a marketable size, about four inches, in about one year. However, the most likely reason for the lack of cultch planting was the absence of a dependable spawning activity because of higher salinities and the presence of heavy predation that accompanied the higher salinities. Moore (1898) had noted during his surveys that the small amounts of cultch that were planted were scattered in intertidal zones along shore and received some protection from drill predation because these areas were exposed daily by tidal action. The young oysters were able to survive the daily exposures whereas drills were forced to retreat with the tide and were given less time to work the area.

Grand Bay

Oyster cultivation in Grand Bay in the vicinity of the Salt Works

Canal and in Quarantine Bay and Bayou Tortillion resembled practices in Bayou Cook in that smaller oysters rather than cultch were planted as a first step. However, it is possible that early planting in this area was really an attempt to improve the quality of the marketable oyster rather than to increase the amount of oysters harvested. Under these circumstances, well shaped, nearly marketable sized oysters gathered from natural reefs located in low salinity waters were stockpiled in saltier water for a period of time ranging from a few days to several weeks (L.S.M.S., 74A). During this period, they may have fattened slightly, but primarily they acquired a saltier, more palatable taste suitable for the raw shop or counter trade. An added impetus to planting in this region was the fact that for some unexplained reason, oysters in the area, especially near the Salt Works Canal, ceased spawning and became fat earlier in the season than those elsewhere in the delta. This meant that they reached the New Orleans market sooner and received a higher price (Moore, 1898).

## Pioneers in Oyster Cultivation

The major developments in oyster cultivation in Louisiana are usually accredited to the Slavonians. Vujnovich (1974), himself a Yugoslav immigrant and oysterman in the 1930s, states that "of the many contributions made by the Yugoslavs to Louisiana, the most outstanding is the development of the oyster industry." Another contemporary researcher (Lovrich, 1960), reported that "...the Dalmatians in Louisiana pioneered the oyster industry...and...over 80 percent of the Plaquemines Parish Yugoslavs are engaged in the oyster trade or related pursuits...". The involvement of Slavonians in the oyster industry is further documented by 19th century newspaper articles and government publications. Zacharie

(1897; 1898) stated that the oyster fishermen are "mostly uneducated Austrians from the Slavonic provinces; commonly known as Takoes." An earlier newspaper article (Bolinger, 1892), commenting on Louisiana's oyster beds, noted that in the southeastern part of Barataria Bay, close to the Mississippi River (Bayou Cook area) "bedding /is/ done here almost exclusively by the "Fajoli" eating sons of Austria, commonly called Packo's." The article further stated that "...they are the most perservering and hardiest set of fishermen on the Louisiana coast, and deserve a great deal more credit than they generally get for bringing the bayou Cook oyster so prominently before the public."

While there were a variety of people with different ethnic or geographical origins involved in Louisiana's early fisheries industry (appendix 3) there are a number of reasons why the Slavonians can be considered instrumental in pioneering the Louisiana oyster industry. These reasons include their previous experience with oysters and boats, their social structure, and their desire to undertake this profession and all the hardships associated with it.

The first Slavonian immigrants to Louisiana were Dalmatian seamen, most from the old Dubrovnik Republic and Bay of Kotor, who began arriving in New Orleans around 1820 (Lovrich, 1960). Many of these seamen left their native lands because of "the declining economic conditions of Dubrovnik and vicinity, during the 1830s and 1840s , and the dissatisfaction with the oppressive Austrian authorities" (Vujnovich, 1974). These seamen were often inspired to leave their ships at New Orleans after several trips to the area convinced them that the climate and culture of this area closely resembled their native one and that there was sufficient opportunity to make a better living here than in their Austrian ruled homeland (Vujnovich,

1974). Many of these early immigrants found employment along the waterfront or on vessels based in New Orleans (Vujnovich, 1974). Because these man were often from the same geographical area of the Dalmatian coast, spoke little English, and had similar jobs on the waterfront, they tended to congregate in a small community which "radiated around the French Market stretching from Bienville Street to Esplanade Avenue along Chartres and Decatur streets including the streets at right angles to Chartres and Decatur" (Vujnovich, 1974).

Some of the early immigrants began migrating into the south delta region in the 1830s to fish and oyster for a living (Lovrich, 1960). It is speculated that these early immigrants to the delta probably resorted to fishing as a primary source of income (Lovrich, 1960). However, because oysters grew so abundantly in the south delta region, they were able to pick up enormous quantities at low tide for food and for shipment to New Orleans for cash. They became the first persons to work the oyster reefs on a commercial basis and to hold oysters near their camps in carefully marked piles to await sale (Zacharie, 1898; Vujnovich, 1974). In the process of culling and holding oysters, they probably noticed that the oysters bedded for a few months improved rapidly in size, shape and taste. Given their previous experience with oyster cultivation in Austria (Peyrer, 1874; Vujnovich, 1974), they were able to quickly adapt the old techniques to the new environmental conditions and quickly become specialists in the business of oyster cultivation on a commercial scale. Many of the Slavonians were from the vicinity of Mali Ston on Bistrina Bay where "the best Adriatic oysters have been cultivated by the suspension method for centuries" (Vujnovich, 1974). Peyrer (1874) writing on the "Fisheries and Fishery Laws in Austria and the World in General" observed that the Valli di Pesca,

on the eastern side of the Adriatic, "...includes inlets, canals or brackish ponds near the coast that have been artificially closed and are used for raising salt-water fish and shellfish." He further stated that Austria "...grants small strips of land near the coast to private individuals for establishing such artificial waters, so that every inhabitant of the coast is enabled to have his own little fish pond or oyster bed." However, this technique alone apparently was not successful in promoting oyster cultivation in Austria since it was observed (Peyrer, 1874) that the oyster beds had "...been almost totally destroyed in some parts...and ... the decline in fisheries in general could be attributed to the lack of legislation designed to protect and perpetuate the natural fisheries resources."

The growth of Slavonian settlements along the river in the lower delta coincided with the emergence of oyster cultivation in the area and with a period of local environmental change. In the early 19th century, a number of natural oyster reefs grew in the area on both sides of the Mississippi River. While they were being depleted through overfishing, the environmental conditions were also changing. The artificial levees along the river were gradually being extended and annual overflows were cut off. Canals dredged through the marsh to facilitate navigation between bayous and from the Gulf to the natural levees aided the influx of saltier Gulf waters into formerly fresh to slightly brackish environments. By the mid to late 19th century, salinity levels had been elevated to such an extent through the combination of natural marine erosion and man-made drainage alterations, and the natural reefs were so overfished, that natural rejuvenation by local spawning was virtually impossible in the vicinity of Bayou Cook (Moore, 1898). Therefore, it was possible that the environmental

changes had as much influence as the cultural abilities of the local oystermen in the emergence of cultivation practices in this area. If the Slavonians wanted to remain in the area and continue their oyster businesses, they had to practice cultivation and import seed to replace the dwindling natural reef produciton.

In addition to their technelogical expertise, the Slavonians possessed a social structure that could foster such a labor intensive industry as commercial oystering. They maintained close communication with their homeland and letters describing their economic successes provided an incentive for more of their friends and relatives to come to Louisiana. As the individual businesses expanded or as some members left either for other occupations or to return to Dalmatia, new recruits were made from relatives in the homeland. Marko Cibilic (1977), an oyster fisherman at the turn of the 20th century, reported that it was a standard procedure for young boys like himself (early teens) from the Peljesac Peninsula in southern Dalmatia to accompany an older relative on his return to Louisiana to work on the oyster grounds (Vujnovich, 1977).

The first wave of immigrants, many of whom simply jumped ship in New Orleans, was followed by a second wave whose actions have been described as follows (Vujnovich, 1974):

> The "second-wave" immigrants were more fishermen than career sailors, and upon arriving in New Orleans, instead of remaining on the city's riverfront or signing on one of the New Orleans-based vessels, they moved down to the fish, shrimp and oyster waters of Plaquemines parish. Raised on the shores of the Adriatic, expertly trained in the art of fishing and small craft handling, they had no difficulty in adapting to the Louisiana bays and bayous and to the Gulf waters in general.

As early as the 1830s small, sparsely scattered Dalmatian oyster camps about one fourth mile apart emerged in the lower delta (Lovrich, 1960).

By the 1840s, several camps had been consolidated into small villages on the higher elevations. Some of these were better developed by the 20th century and became known as Buras, Empire, Ostrica and Venice (Lovrich, 1960).

Because a successful oyster enterprise is labor intensive, the pioneers were forced to band together in groups of two or more to pool their resources and to gather the oysters, man the boats, provide logistical support at camp, and market the harvest to dealers in the vicinity. The following account by a 19th century investigator (Zacharie, 1898) provides a vivid description of the operations of many of these pioneering oystermen:

> ...Small colonies of them "squat" on any available shore, generally along some stream, bay or lake emptying into the Gulf, regardless of the ownership of the land, erect their huts (Fig. 14,15), and, with the capital of a pair of tongs, a skiff or two and a small stock of rough provisions, usually advanced by the dealers in the city, embark on the trade of oyster fishing. Few of them own luggers, or engage in the business of forwarding their oysters to market. From time to time they recruit their helpers from the freshly arrived of their countrymen, who knowing neither the language or the country, go to "learn the trade" at a nominal wage as a sort of apprenticeship receiving as a part compensation for their labor, board and lodging such as it is.
>
> The master fisherman or "captain" as he is termed, thus equipped and assisted, starts out in the planting season and transports from the natural beds skiff loads of the shellfish, which he deposits in the brackish bayou or lake, which he has selected near his cabin, marks his beds of "plants" with stakes to designate his ownership and keeps "watch and ward" over his possessions until his crop is ready to ship to market.

The first oystermen in a region naturally picked the best bedding grounds, i.e. those with a firm mud substrate and adequate tidal exchange. Later arrivals to the area would be forced to purchase grounds from them or to prepare the remaining, less desirable substrate by making it firmer through the addition of shells or even sand. It appeared that

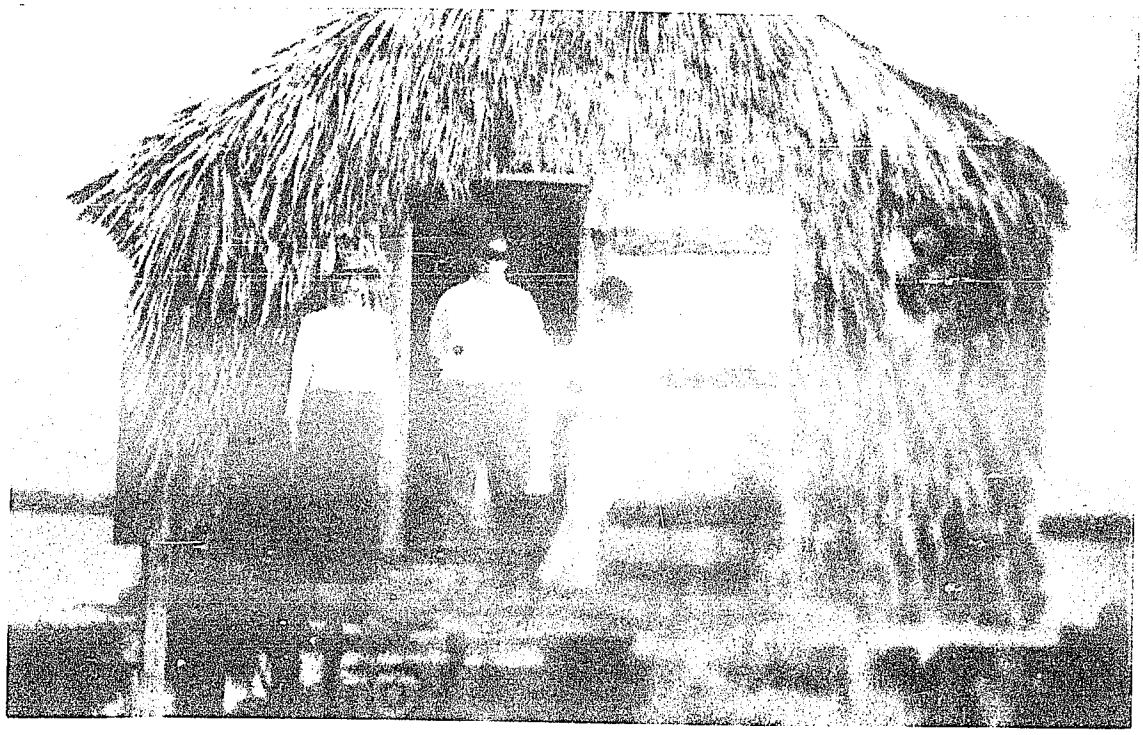


Fig. 14 An example of a rather crude type of oyster camp erected on Bayou Brouleau in the Louisiana marshes (Gates, 1910).

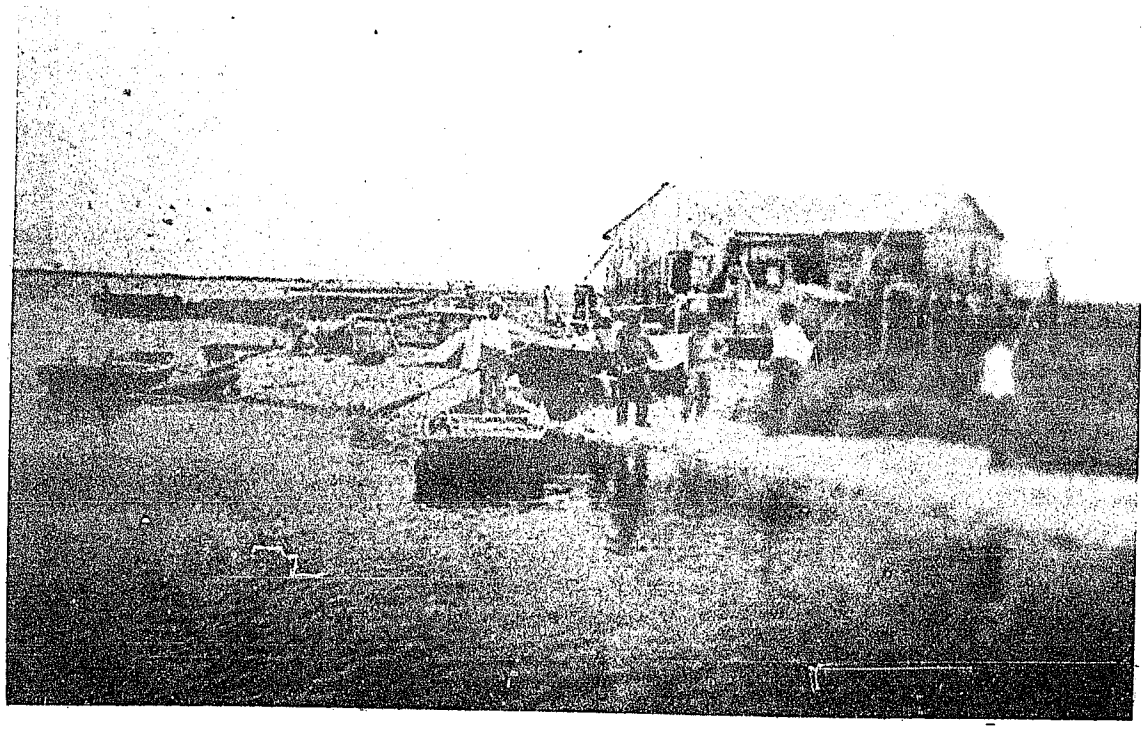


Fig. 15 An example of a more substantial oyster camp located in the marshes of coastal Louisiana. The owners were hand tongers who occupied the camp year-round (Gates, 1910).

in the late 19th century, men would seek out new grounds as long as they were available, rather than exert the extra effort required in preparing bedding grounds. As late as the turn of the century, Moore (1898) reported that there was little effort to improve bedding grounds in Bayou Cook and Whale Bay even though this was a highly desirable location and men expressed their desire to have a larger area to cultivate.

## Development of Cultivation Techniques

In the early to mid-19th century, sufficient quantities of near market size oysters could be tonged (Fig. 16) from reef formations located near the oyster camps in the marshes. The larger oysters were culled (Fig. 17) and temporarily deposited in a collection pile in shallow water at the camp site while a full load was being gathered. If the price of oysters was too low to meet expenses involved in gathering and transporting the oysters to market, they might be held until the price increased (Moore, 1898). The smaller oysters would be replanted for further growth. The basic idea of separating beds according to size was followed by oystermen planting seed around Bayou Cook. Vujnovich (1974) noted that between 1850 and the 1950s oystermen culled their plants into three piles and marketed them according to size. The oyster shells could be scattered along the marsh edge to collect spat, redeposited to improve soft oyster growing bottoms, or placed around the camp to increase the size of the campsite (Moore, 1898; Moore and Pope, 1910; Vujnovich, 1974). If the shells were used as cultch, they were probably allowed to dry in the sun until being scattered just prior to the spawning season. If planted too early, the surfaces would become fouled with sediment or living organisms and be unsuitable for spat attachment (Galtsoff, 1964; Van Sickle, et al., 1976; Hofstetter, 1967).

Fig. 16 Tonging oysters from grounds located in shallow water in coastal Louisiana (Jefferson Parish Yearly Review, 1940).

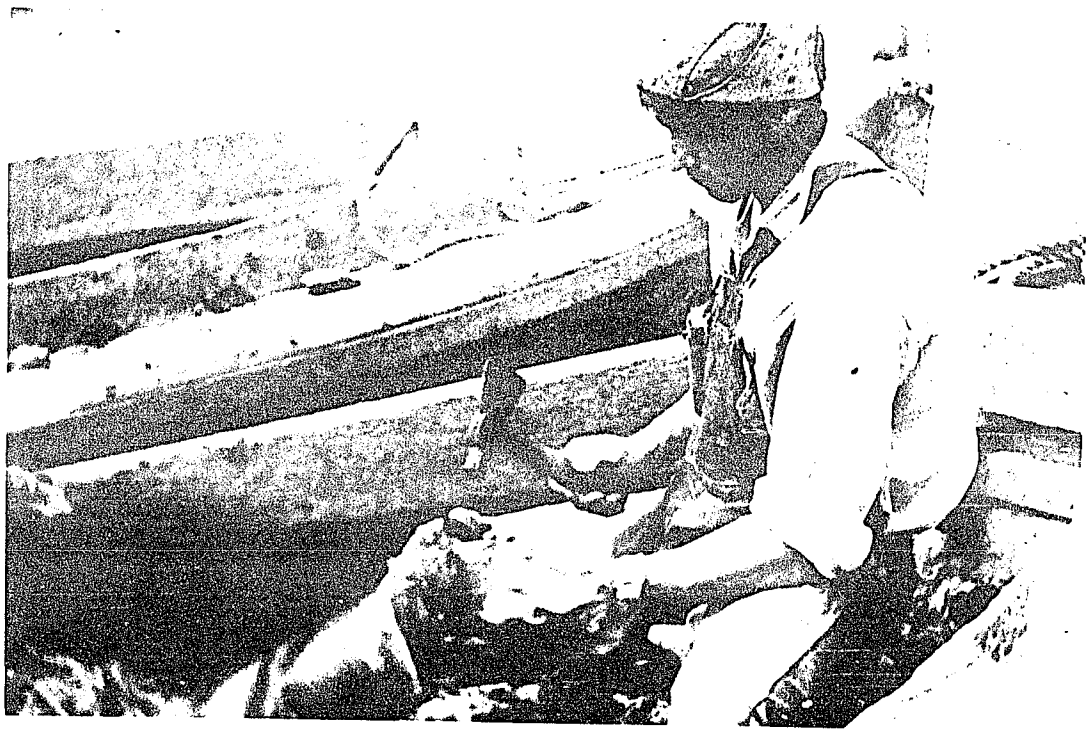


Fig. 17 Culling oysters in order to separate the market size from those requiring further growth (Jefferson Parish Yearly Review, 1940).

Sometimes market size oysters were temporarily held in collection piles near camp in order to improve their appearance. It was discovered early, possibly in the vicinity of the Louisiana Marsh, that oysters gathered from the saltier waters and deposited in fresher waters near collection and marketing sites showed a rapid and substantial increase in meat size within 24 hours. While this was merely a bloating process due to absorption of water into the tissues, the oystermen referred to it as a fattening process (Moore, 1898). The end result was a plumper-looking oyster that commanded a higher price at market. This act did not actually improve either the quality or the quantity of oysters and can not be considered to be a true cultivation technique. In fact, when these oysters were canned and shipped out of state they resumed their small, watery, pre-bloated condition when opened, thereby giving Louisiana oysters a poor reputation nation-wide (Zacharie, 1897).

Another reason for holding oysters was to actually improve their quality. In order to achieve this, marketable size oysters gathered from natural reefs located in fresh-water were stockpiled in saltier waters for a period ranging from a few days to several weeks. Unlike the bloating process, this technique did not change their size, but they did acquire a saltier, more palatable taste. This procedure was probably first applied to large oysters intended for the New Orleans raw shop trade, possibly in the vicinity of the Salt Works Canal east of the Mississippi River (L.S.M.S., 74A).

Oysters that were to be sold in the shell were kept in shallow water near camp until the time of sale. At that time, they were retonged and delivered to the buyer or transported to market. During warm weather oysters would quickly die and spoil if exposed to the elements while in

freezing weather they would freeze, burst open and be unsalable by the time they reached market. Therefore, oysters were held in water as long as possible prior to transport to market. At times, if the boats carrying either seed or marketable oysters were detained due to bad weather, calm winds, or too shallow waters, the oysters would be temporarily tossed over board until the journey could be resumed (Zacharie, 1898; Vujnovich, 1974).

By the mid to late 19th century, cultivation to improve both the quality and quantity of oysters was becoming well established in the lower delta. Oysters grown around Bayou Cook received extra special handling because most of the cultivation was carried on by Slavonians who took special pride in their work and because the oysters were primarily for the counter stock or raw shop, and had to be of the highest quality. Often these oysters were handled several times during the course of preparation for market (Table 2).

Table 2

Major Steps in Oyster Cultivation Using Seed

1. Travel from oyster camp to public oyster reefs,
2. Tong a boat load of small oysters,
3. Return to private bedding grounds,
4. Deposit oysters on staked bedding grounds,
5. Ten to 18 months later retong oysters from bedding grounds,
6. Return to camp and cull oysters into three or four piles according to size (small, medium, large, unmarketable),
7. Redeposit culled oysters in piles according to size on specially prepared hard substrate; replant oysters that are too small for sale; and put shells around camp or deposit them in order to prepare firmer reef substrate for new oyster beds,
8. Oysters for raw shop market are retonged and transported to market either up river in New Orleans or to "buy" boats (Appendix 1),

9. Counter trade oysters were transferred to saltier waters for a few weeks or months prior to sale in order to improve their taste (Vujnovich, 1974; Waldo, 1957; McConnell and Kavanagh, 1941; Zacharie, 1898).'

In the very earliest stages of the industry, individual oysters were broken apart from their densely clustered formations and planted by hand in a row under shallow water in order to insure rapid, uniform growth, a well rounded shape and fat meat (Vujnovich, 1974). In all probability, this practice did not continue for an extended period of time. It was a very time consuming process, and as the demand for oysters increased, a person who put this much labor into his crop naturally harvested fewer oysters than an oysterman who merely collected them or devoted less effort to cultivating them. Also, the cost of row planted oysters was probably not sufficient to justify the extra effort. Furthermore, by trial and error methods, it was probably soon discovered that such elaborate care was unnecessary because small oysters that were merely separated and scattered on a firm bottom grew into as desirable a shape and size as did the row planted ones.

By the latter part of the 19th century, small oysters were being gently broadcast by shovels or scoops from shallow draft skiffs anchored on the bedding grounds (Fig. 18). These grounds were considered the private property of those who transplanted the oysters, and their boundaries were delineated by stakes driven into the mud (Fig. 19). In the early years, when there were fewer persons engaged in the industry, common courtesy and respect for another person's efforts as well as the threat of being shot by the owner, probably were sufficient to keep poaching at a minimum.

However, protecting planted oysters from natural enemies was a constant and sometimes frustrating battle. Whereas the oyster drill generally confined its destruction to saltier waters and smaller oysters, the drum

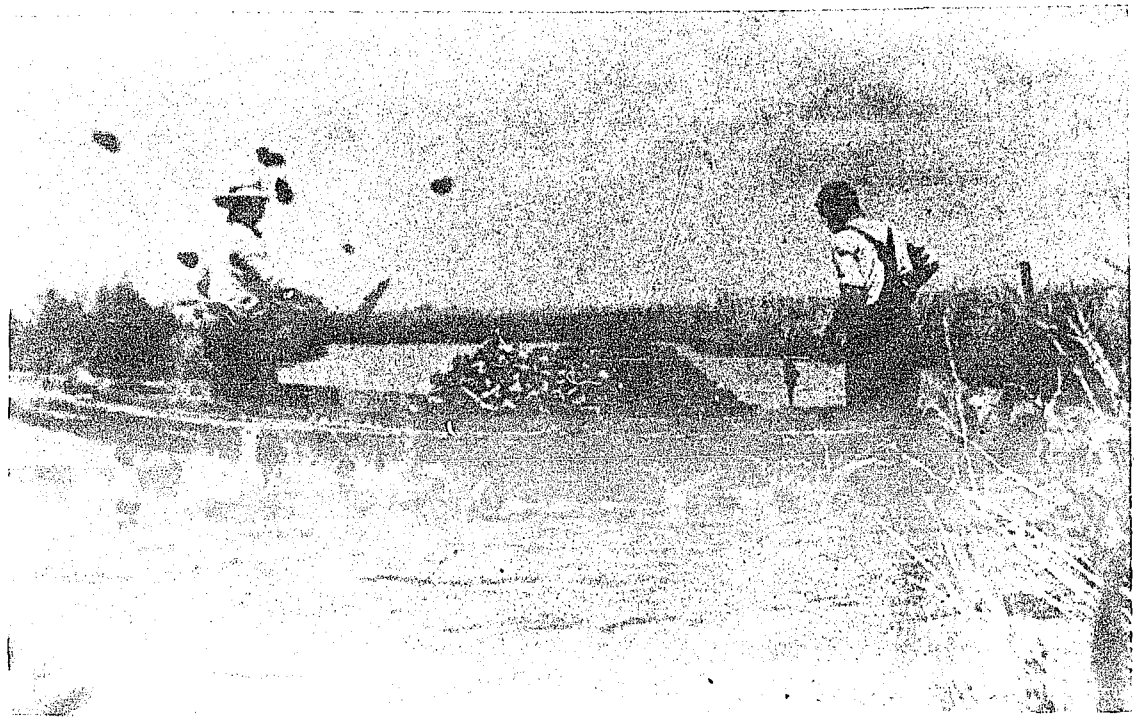


Fig. 18 Oysters being shoveled from a skiff onto private oyster beds located in a shallow tidal channel in the Louisiana marshes (Jefferson Parish Yearly Review, 1940).

Fig. 19 A fenced, private oyster bedding ground located west of the mouth of the Mississippi River. The sailboat is a lugger, commonly used in harvesting and transporting oysters (Gates, 1910).

threatened larger sizes of oysters and could be found in all ranges of salinities throughout the year. A school of these fish are able to consume the meats from 30 or 40 barrels of oysters bedded in one day. Just as the planters east of the river and at the mouth of the river were forced to do, those in Bayou Cook also tried to protect their newly planted seeds. It was reported that they sometimes encircled their beds with old seines supported on pickets, put lines with rags attached to frighten the fish and as a last resort constructed substantial stockades around the grounds (Fig. 19; Moore, 1898). In describing the significance of drum destruction on planted oyster beds in the vicinity of Bayou Cook, Moore (1898) stated that:

> ...the damage done to planted beds is usually wrought very soon after the separated and culled oysters are laid down. After several days have elapsed the oysters seem to be immune, probably either because they have sunk slightly into the mud on which they have been planted or because they become more or less covered with sediment, which makes them less conspicuous. If the drumfish can be kept off for a week or two there appears to be but little danger of an attack thereafter, but if for any reason the oysters are rebedded the same difficulty is encountered as before.

By the latter part of the 19th century, most of the larger, easily gathered oysters had been harvested from the public, commercially worked oyster reefs in the lower delta and oystermen were forced to seek additional sources. Oystermen in this region were the first to seek a solution to this dilema by planting small oysters or seed on areas that they reserved as their private oyster bedding grounds. Oysters planted from seed were usually marketable in about one year and could provide an oyster planter with as much as a four to one return on their original planting.

However, west of the Mississippi River, in the vicinity of Bayou Cook transplanting seed was more complicated than it was east of the river in the

late 19th century because of the lack of major concentrations of natural reefs in the area. Reefs in this region were never as abundant as those east of the river and by the late 19th century, they were almost extinct. While seed reefs were abundant east of the river, there was no easy, dependable means of transporting them across the delta until artificial locks were built at Ostrica and Empire around the turn of the 20th century. Prior to construction of the locks, planters had to rely on natural breaks or crevasses through the natural levees in the lower delta in order to transport seed from east of the river to their bedding or planting grounds to the west.

During high river stages, some oystermen sailed through channels up to the Jump Crevasse, across the river and through Baptiste Coulette Bayou or Cubit's Gap to seed beds in the east. They also took advantage of any natural crevasses in the levee, such as the Bohemia Crevasse of 1897 to reach thesegrounds. It was fortutious that crevasses not only provided access through the levees but also resulted in a bumper seed crop that could be harvested for transplanting. During low water stages, when cross-river channels and canals were blocked by bar mouth deposits, oystermen west of the river sailed to the west seeking seed. The natural reefs of Barataria, being closer to the planting grounds of Bayou Cook were the first to be harvested to the point of commercial extinction. Consequently, the planters had to go first to Timbalier Bay and later to Terrebonne Bay for their seed (Moore, 1898; Bolinger, 1892). Obviously, this was an expensive venture since planters had to travel a longer distance (100 to 120 miles round trip to Terrebonne Bay) and after 1886, pay a tax to the parish from which the seed oysters were taken. Furthermore, if seas were rough the planters traveled via the canal network and paid tolls. Such

effort, however, was justified because oysters grown in the vicinity of Bayou Cook commanded the highest price on the New Orleans market thereby offsetting the extra expense involved in procurring seed.

During the earliest stages of gathering oysters for sale, there was probably little emphasis placed on differentiation of oysters according to quality standards. Prior to establishment of steam canneries, it is likely that the main criteria used in harvesting oysters for sale is that they be sufficiently large and well shaped to be easily opened and consumed. With the introduction of steam canneries, clumps of tightly clustered oysters could be steam opened and the meats shaken loose.

By the mid-19th century, three major commerical categories of oysters excluding seed, were established: 1) raw shop, 2) counter trade and 3) steam cannery. While all three classifications of oysters were found in coastal Louisiana, growing under natural but slightly different environmental conditions the steam canned or reef oysters were the most abundant. Oysters suitable for the raw shop or counter trade grew in relatively limited quantities under natural conditions, but quickly became the primary object of cultivation in the mid 19th century because they commanded a higher price.

All three major classifications are composed of the same species Crassostrea virginica or commercial oyster, but differ mainly in quality as determined by shape, fatness, size and flavor. The steamers or steam canned variety were small, misshapen and relatively poor in quality. They were very abundant, growing in densely clumped reef formations throughout much of coastal Louisiana. Because of the difficulty in shucking, these oysters were primarily suitable only for steam opening and canning. Often

the spat generated on these dense, natural reef formations were broken into single oysters and transplanted as seed oysters onto private bedding grounds (McConnell and Kavanagh, 1941).

The second oyster category, the raw shop, consisted of larger, better shaped and higher quality oysters that could be shucked individually. A small quantity of these oysters grew naturally in small, loosely clumped formations in coastal Louisiana. In order to increase the supply of these oysters, the larger reef clumps were separated and evenly spread over a hard surfaced bottom so that they could increase in size and improve in shape. Whether grown naturally or cultivated, these oysters were larger and easier to shuck than steam cannery oysters. They could be opened quickly by hand and were sold raw locally or canned, packed in ice and shipped to nearby markets (McConnell and Kavanagh, 1941).

The third and perhaps most notable class of oyster was the counter stock or half shell variety. Much effort went into making this the highest quality oyster and it commanded the highest prices. Once these cultivated oysters reached near market size, they were transferred to special "fattening grounds" for a few months in order to become plump and salty, two qualities that were a prerequisite for oysters that were to be consumed raw on the half shell (Pausina, 1970; Gates, 1910). These grounds were located in areas of high salinity and abundant food supplies and in a short time the oyster meats increased in size, being genuinely fat and well flavored. Usually, by the time they were ready for this final planting step, they were sufficiently large to be immune to heavy predation by drills. However, if they were still small enough to be susceptible to drum attacks the grounds were often protected by fence-like enclosures. Oysters treated in this manner and of this quality, whether from Bayou Cook or elsewhere in

Louisiana where conditions were similar to those of Bayou Cook, met the highest standards of excellence and were invariably marketed by the generic name Bayou Cook oysters. This type of oyster is generally considered to have been initially developed in the lower delta around Bayou Cook through the early cultivation efforts of the Slavonians (Ingersoll, 1889; Moore, 1898; Vujnovich, 1974; Bolinger, 1892).

## Tools Associated with Initial Oystering Activities

A great variety of tools was not required in the gathering of oysters. In the early phases of the oyster industry when oysters were mainly gathered by hand by individuals wading in shallow water, the only requirements were a shallow draft skiff to navigate through coastal waters in search of oysters, baskets to hold and transfer oysters, a hand held instrument such as a hammer or hatchet to break up large clusters of oysters, and perhaps a pair of gloves to protect hands and a rake, such as a garden rake, to gather the oysters in a pile for easy pick up.

Due to the unpleasantness of wading in cold water during the winter season and to the depletion of beds in shallow water, which forced an extension of the search for oysters into deeper waters, an additional tool, a pair of tongs, was quickly adopted into the trade. It is not known whether Louisiana oystermen adapted tongs such as those used along the Atlantic seaboard (Fig. 20), or whether, through modifying the previously utilized rakes, they constructed their own style of tongs. It has been speculated that ordinary garden rakes were crossed to extract oysters that had been raked into a pile. Later these rakes, with teeth pointed inward, were hinged together about two to three feet from the bottom of the tong shafts and operated like a blacksmith's tongs (Vujnovich, 1974).

By standing in a skiff or on the gunnals of a boat, an oysterman could grasp each of the handles in his hands and open the rake basket by spreading his arms apart. Using short, jerking motions of his arms he could move the rakes over the bottom, feeling and listening for the dull crunching sound of metal striking shells. When he had shuffled enough shell into the rake blades, he would bring the handles together, thereby closing the rakes and securing the shells in the basket. With several rapid, uplifting motions, the metal basket containing shells could be brought to the surface and swung over the side of the boat. Holding the handles gently and slightly apart, a few shakes would be sufficient to dislodge the shells from the basket and once again the tongs could be swung over the side of the boat and dropped to the bottom for another load.

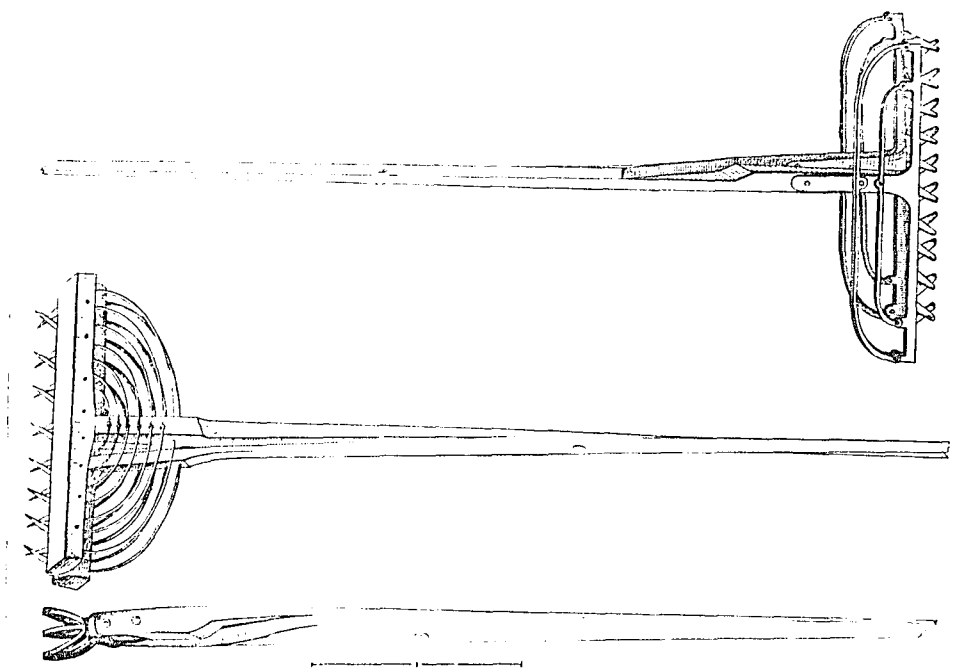


Fig. 20 Examples of tongs and nippers used in the gathering of oysters. (drawing from U.S.C.F.&F., 1887).

The length of the handles varied, usually ranging from 6 to 16 feet, and depended upon the depth at which oysters were to be gathered. If a man was working waters of varying depths he would be required to have more than one pair of tongs since it is impossible to work deep water with short tong shafts and awkward to tong shallow water with long shafts. Because most oysters were gathered from relatively shallow waters the tongs were usually short. The use of tongs expanded the length of time, i.e. seasonal basis, and the geographical range from which oysters could be harvested. It also required more investment including the price of one or more pair of tongs, a certain degree of skill in handling the tongs and very strong arm and back muscles.

There are accounts of nippers (Fig. 20) being used by some of the oystermen operating in coastal Louisiana in the late 19th century (Moore, 1898). Nippers had a smaller tong head and were a lot lighter in weight than regular tongs. They were used primarily to pick up single oysters from water that was too deep or too cold for wading. The extent of their utilization was determined by the ability of the nipperer to see oysters lying on the bottom. Therefore, their use was confined to relatively shallow, clear water. These conditions were present only during calm weather and in the cooler months of the year when turbidity from phytoplankton and sediment was minimal.

There are few data available to describe the extent and distribution of the use of tongs in the oyster industry. However, census records (Collins and Smith, 1891) indicate that the vast majority of tongs were recorded in seven parishes and that virtually all of them were used by men operating close to shore (Table 3 ). These data also indicate that the price of a pair of tongs ranged from a low of about $6.00 to a high of about $7.50.

Tongs used on vessels appear to have been more expensive possibly because they may have had longer shafts for tonging in deeper water that was made more accessible by vessels than the smaller shore based boats or skiffs.

Table 3

Number and Value of Tongs Used in Oyster Fisheries in Louisiana in 1889 and 1890

| | 1889 | | | | 1890 | | | |
|---|---|---|---|---|---|---|---|---|
| | Vessel Based | | Shore Based | | Vessel Based | | Shore Based | |
| Parish | No. | Value | No. | Value | No. | Value | No. | Value |
| Jefferson | 20 | 131 | 280 | 1,830 | 17 | 115 | 290 | 1,892 |
| Orleans[1] | 210 | 1,409 | 0 | 0 | 189 | 1,257 | 0 | 0 |
| Plaquemines | 10 | 60 | 96 | 640 | 10 | 62 | 100 | 670 |
| Lafourche | 2 | 12 | 160 | 1,050 | 2 | 14 | 165 | 1,080 |
| Terrebonne | 2 | 15 | 365 | 2,327 | 7 | 49 | 375 | 2,387 |
| St. Mary | 42 | 315 | 160 | 1,050 | 42 | 294 | 162 | 1,070 |
| Cameron | 0 | 0 | 4 | 25 | 0 | 0 | 4 | 25 |
| Total: | 286 | 1,942 | 1,065 | 6,922 | 267 | 1,791 | 1,096 | 7,124 |

(Collins and Smith, 1891)

[1]There appears to be a discrepancy in this data in that tongs are recorded in Orleans Parish, which was not an oyster producing parish in the 19th century, but omitted for St. Bernard Parish which was a very productive region. A possible explanation for this is that many of the people oystering in St. Bernard lived either in Plaquemines or Orleans or sold their catch through markets located there. When the census data was collected it probably recorded people at the market centers or near their domicile if it was within easy access. There was probably little effort exerted to seek oystermen living in the Louisiana marshes in order to interview them or record their equipment.

Even in the latter part of the 19th century, dredges (Fig. 21) were not commonly used to gather oysters from coastal waters in Louisiana. Data obtained on the Louisiana oyster industry in the early 1890s (Collins

and Smith, 1891) made no mention of the use of dredges in Louisiana waters. While they were much more effective in gathering large quantities of oysters in a short period of time, they were more expensive to install and operate than tongs. In many areas, the waters were too shallow, less than six feet, to successfully utilize them. Also, where private grounds were close together, it was difficult to dredge one ground without also gathering oysters from adjacent grounds. Furthermore, local oyster interests were often opposed to dredging because it gave some oystermen an unfair advantage over non-dredge users. The Legislative Act 110 of 1892, even prohibited the use of dredges on natural oyster grounds, and this provision remained in force until 1904, when new legislation permitted their limited use. A major reason behind this legislation was that dredging was not selective, and when used on natural oyster bottoms, the young unmarketable oysters, were either crushed or smothered. The non-discriminate removal of all materials

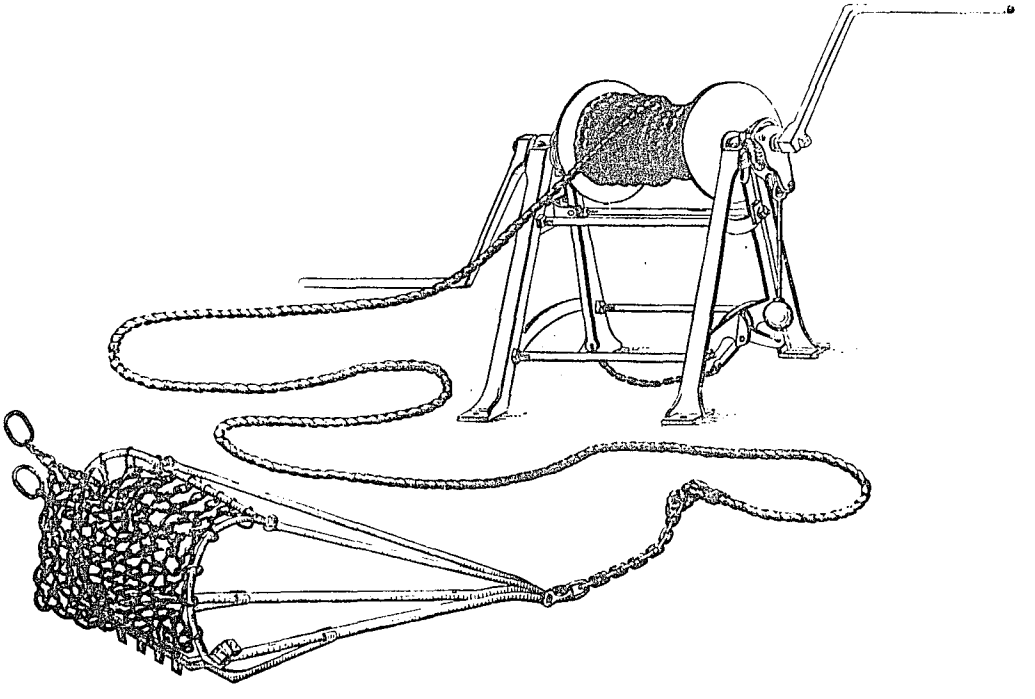


Fig. 21 Type of oyster dredge used in the oyster industry in the late 19th century. This particular model was used in the Chesapeake Bay region (U.S.C.F.&F., 1887).

from natural reef bottoms also prevented the area from perpetuating or re-establishing itself naturally.

By the beginning of the 20th century, oyster dredge boats were being more commonly used (Fig. 22). Leopold Taliancich is credited with installing one of the first, if not the first, pair of dredges on his boat in 1905 (Vujnovich, 1974). These early dredges were operated manually, by a man turning the winch to raise the dredge basket from the bottom after it had gathered a sufficient quantity of bottom material. While this tool greatly enlarged the quantity of oysters a crew could gather, it was still physically demanding. However, power operated dredges were quickly adopted by Louisiana's oystermen soon after the turn of the 20th century. At this time, it was more commonly understood that dredges greatly expanded the amount of oysters that could be harvested and if properly used it was a labor saving devise for management and cultivation of private oyster grounds. Among the first to install power dredges were John and Anthony Zequra. These two brothers of Slavonian origin installed the first power operated dredges on their lugger in 1913 (Vujnovich, 1974).

Once adapted these two major oyster gathering devices, the tongs and the dredge, have remained basic to the oyster industry even into the latter half of the 20th century. Tongs retain the advantage of being suitable for selectively working portions of a ground or small beds, for working in shallow water or for gathering a small quantity of oysters. However, in deeper water and on larger beds, dredges are ideal for harvesting all of the oysters in a short period of time. This allows a man to collect all marketable oysters and prepare the ground for planting another season's crop either in the form of seed oysters or cultch material. This process gives a degree of uniformity to the size, shape and age of the oysters

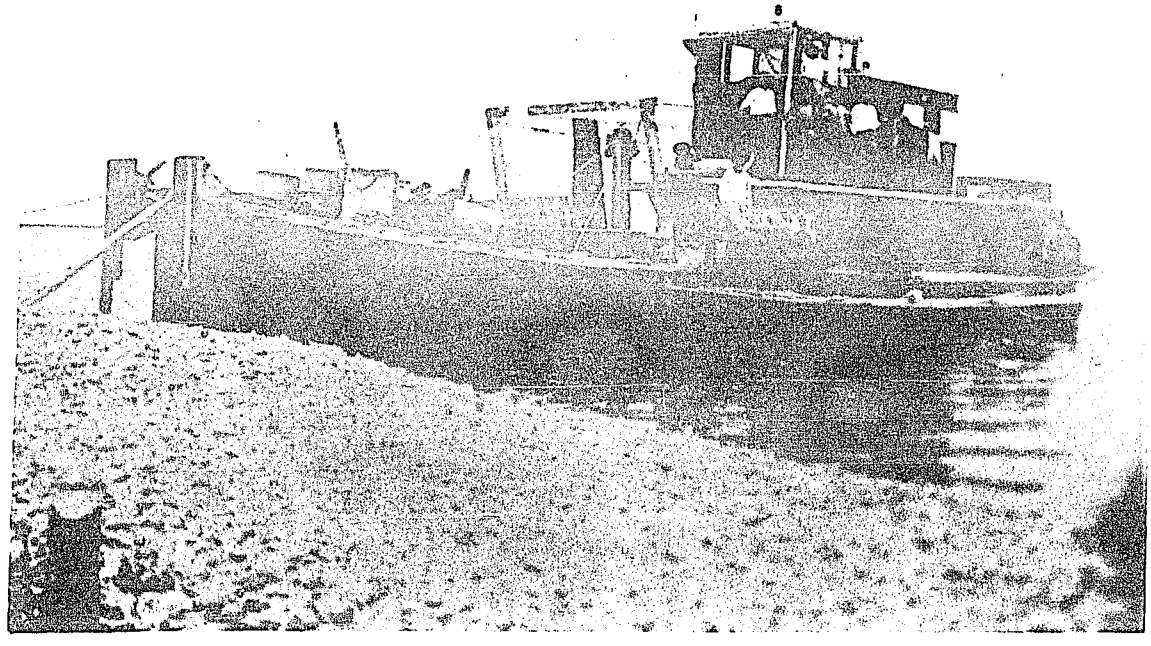


Fig. 22 A typical oyster dredge boat used to harvest oysters from private grounds and natural reefs in coastal Louisiana and Mississippi (Gates, 1910).

being cultivated and it established the operation of oyster cultivation on a systematic level.

## Transportation and Marketing Procedures

In the early part of the 19th century, prior to specialization within the industry, oysters were either marketed by the men who collected them close to where they were gathered, or they were sold to boats which transported them to market. Later, in the latter half of the 19th century as the market demand increased, some men began to specialize in buying oysters and transporting them to market during the oyster season. The means of transporting oysters to market, and their final destination was

determined by the period in which the marketing occurred and the class of oyster being marketed.

As the number of buyers increased in the latter half of the 19th century, they acquired oysters by traveling to the grounds where the oysters were being collected, or they met the oyster boats at a predetermined spot. Oystermen fishing near the Mississippi River traveled up to the natural levees through canals dug in the marsh in order to hand carry oysters across the levee to boats waiting at river landings. Many canals (Fig. 23) shown on early maps were dug by oystermen especially for this purpose.

In the Louisiana Marsh, "buy" boats (Appendix 1) were stationed at major entrances into the marsh to purchase from oystermen using these routes. Three Mile Bayou, just east of Lake Borgne, was one such access point where "oyster freighters resort to secure their fares from the luggers and other craft engaged in the active work of oystering" (Moore, 1898).

During the sailing era, oysters transported along routes other than the Mississippi River were very dependent upon the wind for reaching markets before the oysters spoiled. Along the Mississippi, the cargo could continue to move even under adverse wind conditions through the "cordelling" process, whereby the oystermen walked along the levee pulling the boat or hired a horse or mule to do it for them. Once steam powered boats became more common on the river in the mid 1800s, they could be hired to pull, or in the case of tug boats, to push, the cargo to market, but this was expensive and cut heavily into the profits. Canneries with their larger capital investments and the need to have oysters delivered on time were among the first transporters to use steam powered boats and barges to deliver

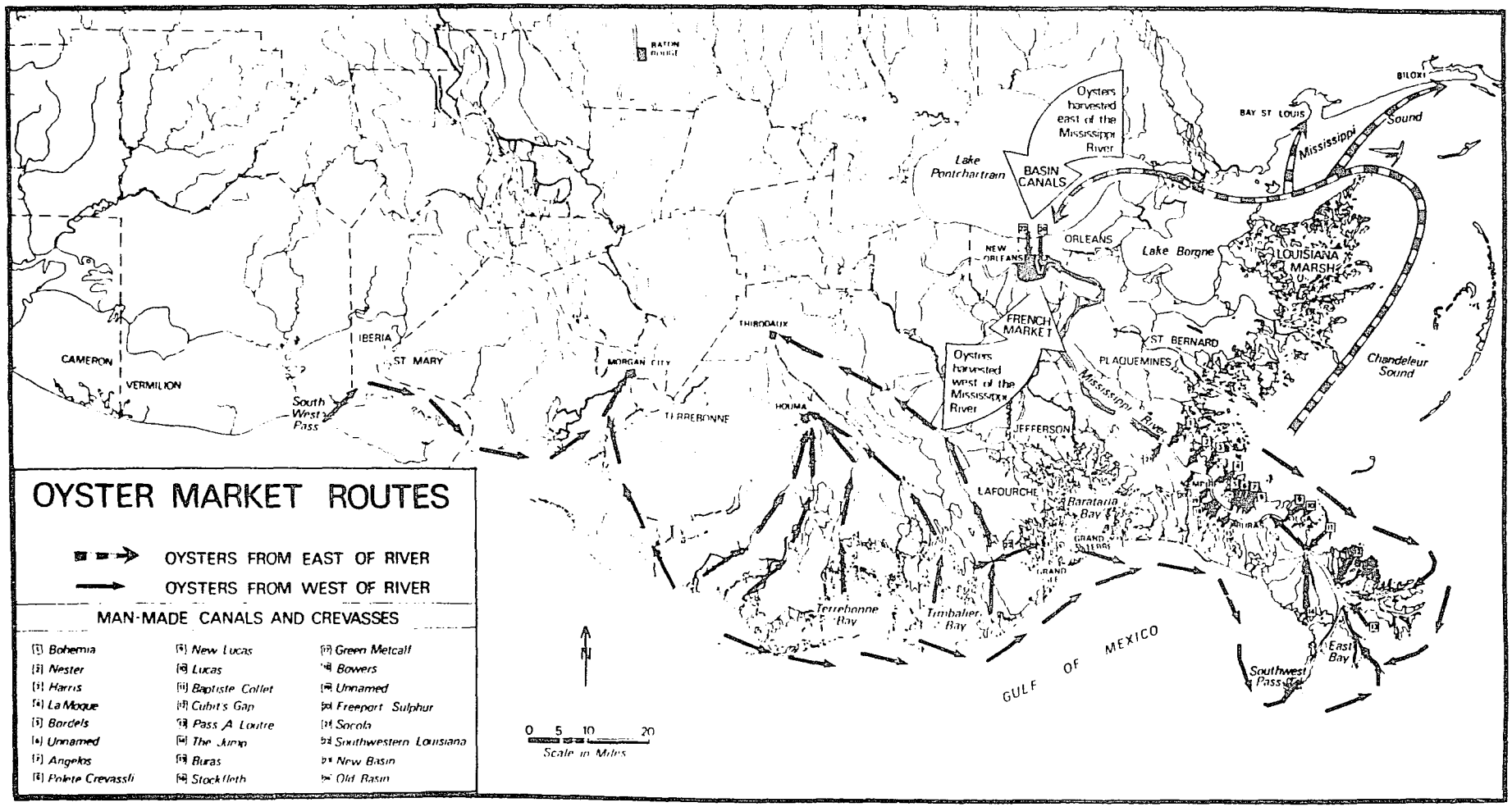



Fig. 23 Major market routes whereby oysters were transported from harvesting sites to market. Also shown are major man-made canals and crevasse openings used in transporting oysters to the Mississippi River from adjacent water bodies.

their oysters from the tonging grounds to the shucking or steaming houses.

There were essentially two types of oyster markets in the late 19th century in New Orleans (Ingersoll, 1889; Table 4). The first class was generally inferior in quality and consisted primarily of oysters harvested from the natural reefs east of the Mississippi River in the vicinity of the Louisiana Marsh. They reached the New Orleans markets via the market landings in the Old and New Basins, chiefly the former (Fig. 24). These oysters were often called "raccoon" or "coon" oysters on account of their long slender shape or "Basin" oysters since they arrived in New Orleans at the Basin landings. In general, the size boat and number of crew members delivering to this market were smaller than those sailing west of the River to the French Market landings in front of the city (Ingersoll, 1889).

Table 4

Major Marketing Classes of Oysters in New Orleans According to Value, Quality and Origin

| CLASS | LOCATION OF HARVEST | LOCATION OF MARKET | MARKET VALUE |
|---|---|---|---|
| I | East of River<br>1) Louisiana Marsh (natural reefs)<br>2) Mississippi and Chandeleur Sounds (natural reefs) | Old and New Basin Canals | 50¢ to 60¢/barrel ($1.50 max. in 1880) |
| II | West of River<br>1) 1st Subclass<br>a-Bayou Chalons<br>b-Four Bayous<br>c-Bayou Fontenelle<br>d-Bayou Cyprian<br>e-Lake Peliot<br>f-Bayou Cook | French Market (Lugger Bay) | $2.50 to $4.00/barrel (avg. in 1880) |
| | 2) 2nd Subclass<br>a-Timbaliers<br>b-Saline Bay*<br>c-East Bay<br>d-Great Lakes (Barataria Bay) | | $1.25 to $3.00/barrel (avg. in 1880) |

* Saline Bay also called Bird Island Sound and Oyster Bay, near Salt Works Canal east of the River.

(Ingersoll, 1889)

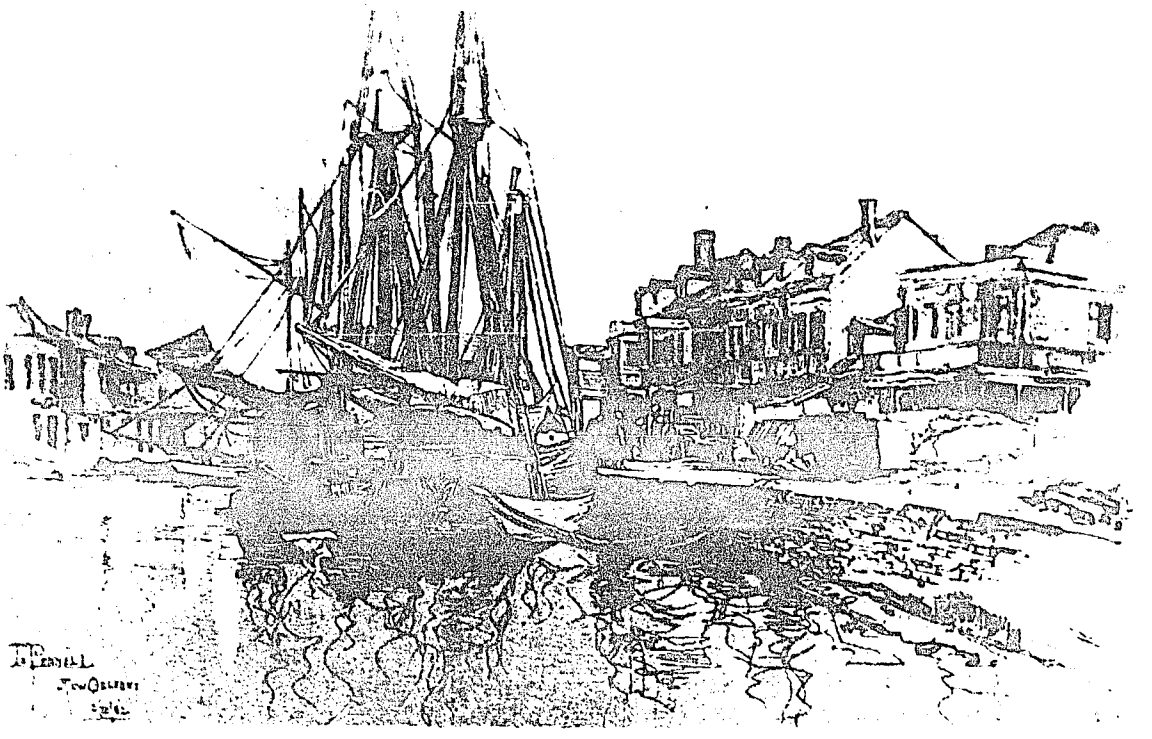


Fig. 24 Vessels unloading cargo at the Old Basin Canal in the early 1880s (drawing by Joseph Pennell, 1882; reprinted in Cable, 1885).

Even during the summer months, oysters entered New Orleans via the Basin Markets, most likely because they could be delivered quickly and the cargo was in less danger of spoiling. At that time and for the first 15 days of the season, they constituted the majority of the oysters sold in New Orleans because they were the first to arrive in the city (Ingersoll, 1889). These oysters, being small, elongated and somewhat watery, were largely sold to canning establishments or shucked for cooking. The price varied from a low, unprofitable rate of 50¢ to 60¢ per barrel (Appendix 1) to an average of $1.50 per barrel in the winter of 1879-1880. During this particular season, 65,000 barrels (170,000 bushels) of reef oysters reached New Orleans through the Basin Canals, delivered by an assortment of oystermen whose ranks had increased substantially over those of the pre Civil War period (Ingersoll, 1889).

The second class of market oyster was harvested primarily from west of the Mississippi River and consisted of a higher quality than those from the reefs east of the River. They reached New Orleans via the French Market landing located on the waterfront in front of the city at the foot of Dumaine Street (Fig. 25). This area was referred to locally as Picayune Pier or Lugger Bay (Daily Picayune, 1898; Vujnovich, 1974). These oysters were sold to sailors and restaurants to be eaten raw on the half shell. They brought a higher price which commonly ranged from $2.00 to $3.50 per barrel in the 1879 to 1880 season (Ingersoll, 1889).

The number of boats and the size of the crew catering to the French Market was larger than those supplying the Basin Markets (Ingersoll, 1889). Around 1880, the number of boats neared 205 and the crews totaled over 615 men. However, the number of barrels recorded as being unloaded at the French Market in 1880, was less than the Basin's; being about 50,000

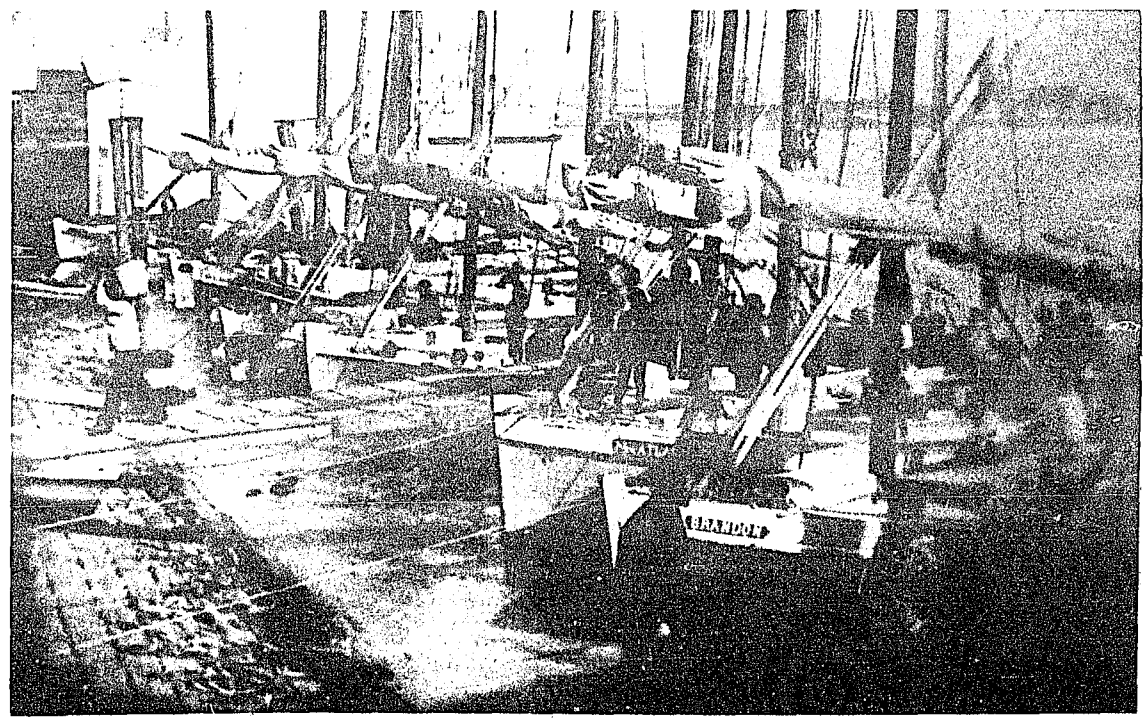


Fig. 25 Oysters being unloaded from luggers docked at the French Market landing around the turn of the 20th century (from Library of Congress; reprinted in Huber, 1971).

barrels or 124,000 bushels (Ingersoll, 1889).

Many of the early transporting craft were designed according to models in use in the Mediterranean at that time. They were called luggers because of their Mediterranean style of rigging or lug sail. Those built by the Slavonian oystermen living around Olga, Empire and Buras were similar to the Leuti which was used in the Dalmatian sardine fishing industry. In a slightly modified version, they were low-decked, shallow draught, one masted, latteen-riged sailboats from 30 to 40 feet long (Vujnovich, 1974). In his discussion of the Gulf coast oyster industry, Kellogg (1910) provided a good description of this type of lugger that served to set the Gulf coast oyster fleet apart from that of the east coast of the United States. However, by the time of his writing this fleet was being swiftly replaced by more modern types of engine powered boats and by 1920, the last sailing lugger had disappeared from Louisiana's oyster grounds (Vujnovich, 1974).According to Kellogg's description luggers ranged from 16 to 40 feet in length and were decked over fore and aft but with the center of the boat left open for storage of oysters or other cargo that might be transported during the off season. Most luggers contained one long mast which carried a large, nearly square sail suspended from a long yard. This square sail's lower corners were tied at the bow and stern on trawlers, enabling it to work across the deck. There was no jib to the rigging. A major advantage of these boats in transporting cargo was that they were fast sailers and could be handled quickly. Supposedly, they were even superior to schooners and sloops in beating to the windward. Their one disadvantage was that they became hard to handle in squalls and could capsize easily.

In some cases, oysters were transported to market by crews other than

Slavonians. One report (U.S. C.F.&F., 1887) stated that:

> ...those employed in this fishing, and also the sailors who own the luggers, are almost altogether Italians and Sicilians, generally of the low order. Their swarty faces, long curly hair, unfamiliar speech, and barbaric love of bright colors in their clothing and their boats, give a perfectly foreign air to the markets. There is not an American style of rig seen, nor hardly a word of English spoken, in the whole gayly-painted oyster fleet of Louisiana.

Even the boats sailing from Grand Isle where most of the early immigrants were of French origin had colorful sails. An early newspaper account (Daily Picayune, 1881) remarked that even the luggers bringing oysters from Grand Isle could be recognized for miles because their sails had been treated with a red oak stain to prevent mildew (Fig. 26 ).

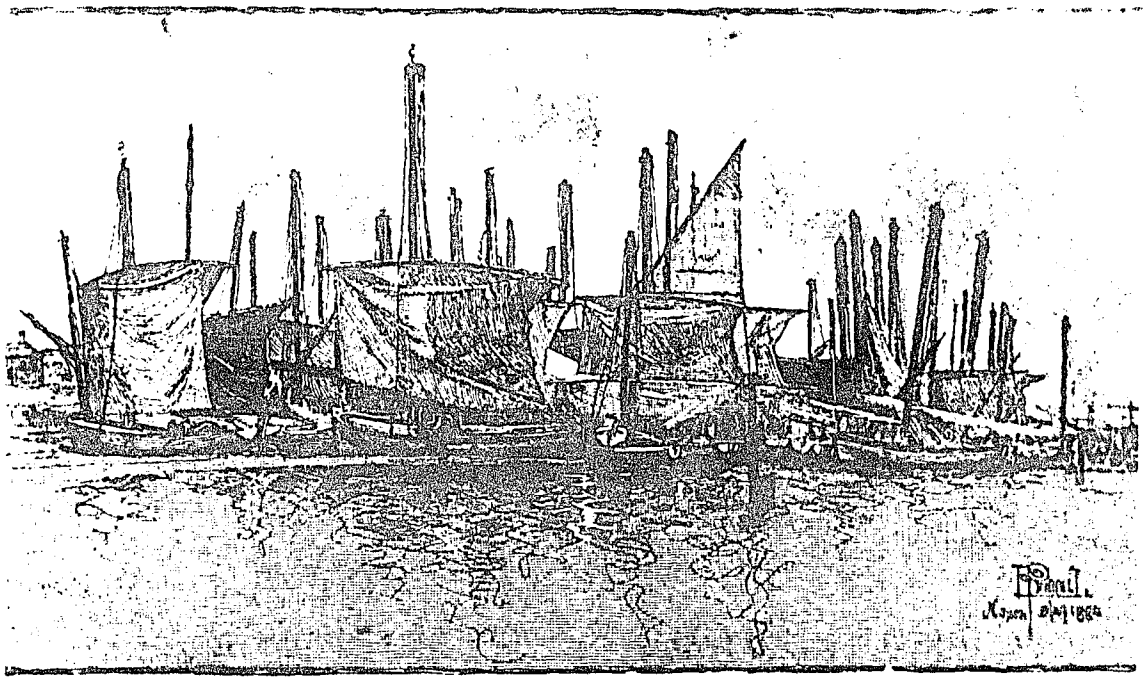


Fig. 26 Luggers transporting cargo from the Barataria Bay region of Louisiana (drawing by Joseph Pennell, 1882; reprinted in Cable, 1885).

In addition to luggers, some oystermen built two masted schooners. These boats were used primarily to transport seed oysters from natural reefs to bedding grounds and to deliver marketable oysters to New Orleans. They were not commonly employed in working the bedding grounds (Vujnovich, 1974). These boats had to be larger and more sea worthy than the luggers in order to endure the high seas that could sometimes develop in the open Gulf during transport of a load of oysters around the mouth of the delta or from reefs in Timbalier and Terrebonne Bays.

Motorization of the oyster harvesting and transporting fleet began at the turn of the century and by 1920, the last sailing smacks had disappeared from Louisiana waters (Vujnovich, 1974). However, even as early as the mid-19th century some oyster transport vessels were powered by steam. Large, company owned steamboats bought reef grown oysters from individual tongers and transported them to canneries along the Gulf coast. (Bolinger, 1892). They had an advantage over sail powered boats in that they could deliver a larger load more quickly and at a predictable time while sail boats were very dependant upon the weather and wind conditions.

Federal surveys showed that by the early 1880s there were 332 professional fishermen recorded in Louisiana and 129 of these were engaged in the oyster business (Ingersoll, 1889). In the process, they used 205 boats to catch and deliver oysters to market. While about forty of these vessels weighed over five tons each, most were generally small, rarely carrying more than a two man crew. Other local accounts placed the number of boats supplying the New Orleans market at between 150 and 200 luggers with a crew of 3 to 6 men (Daily Picayune, 1881). This article further stated that eight of these boats made at least one trip a week from Barataria (Bayou Cook, Chalons and Four Bayous); thirty came from Southwest Pass and

the Salt Works; and 15 arrived from Timbalier (Bayou Cyprian, Fontenelle, and Lake Peliot). While the source of the statistics was not stated, the Picayune reported that "these vessels, and the labor at the fishing banks, give employment to over four thousand five hundred men."

The transporting of oysters from natural reefs and privately maintained grounds generally occupied between 5 and 9 months of the year. Those who owned luggers purely for shipping purposes transported fruit and other produce from coastal plantations to city markets, usually New Orleans, the remaining months of the year. By the late 19th century, each lugger using the city docks paid a yearly wharfage fee of $20.00 to a firm that managed the docks under a leasing arrangement with the city.

Even the manner in which oysters and other produce were distributed once they reached New Orleans had become quite specialized by the late 19th century. Once the luggers were docked at the levee in front of the French Market, the business of transporting the cargo to wagons belonging to the purchaser was assigned to an organization of wharfmen who were paid 15 cents a barrel by the purchaser. The process of unloading was described as follows by Ingersoll (1889):

> ...the boatman having sold his cargo, he then has no further concern; his boat being taken in charge by the carrier, who might be called a "longshoreman" and who delivers all the oysters and sweeps the vessel and puts her in proper condition for the crew. While there is no society of these carriers, strickly speaking, they manage to make their business a close corporation, since no one is allowed to discharge a cargo of any kind from the luggers--oysters, oranges, or fruit--except one of the members of this body. There is a man called the foreman, who receives all the money from the carriers and who divides, the proceeds equally among the different carriers, but just how this is regulated as well as many other of the details of this quasi-organization, is kept as mysteriously secret as possible. The body is an old one and now consists of about 50 men in all, mostly Sicilians and low-grade Italians, and, as near

> as I can judge, the annual receipts for the carriers amount to about $35,000 levied on the oysters, oranges, melons and various fruits.

Prior to motorization of the transporting fleet, the time of arrival and the amount of oysters delivered to markets in New Orleans was not predictable since they depended a great deal on the weather. Therefore, rather than accept orders in advance of delivery, the oysters would be sold on arrival in New Orleans. Usually, those delivering oysters had a standard clientele who received the right of first purchase or refusal on the cargo. These people, when notified that a shipment had arrived, would hurry to the river landing with their wagons to procure their oysters. Those that were not bought by regular customers such as restuarants, boarding houses, oyster saloons, hotels or shucking houses, were sold to other dealers or street peddlers (Bilich, 1931).

Until the 1880s, the majority of oysters reaching New Orleans were consumed locally. The wholesale disposal of oysters was conducted only by a few firms. During the oyster season (in 1881 the season stretched from September 15th to April 30th), business was brisk as oysters were heavily consumed by hotels, country towns, steamboats, local families and boarding house clientele. In 1881, there were four principal wholesale dealers located in New Orleans: Mr. Edward Morgan, having the largest and cleanest firm, as well as Mr. Rosello, Mr. Warner, and Mr. French (Daily Picayune, 1881). Only a small amount, principally fresh oysters, was shipped inland. However, around this period, at least two canning operations were established in New Orleans to process canned oysters in a manner similar to that which was employed in Baltimore, Maryland. However, operations were small, employing only about 30 adult males and 100 female openers, all white and primarily American and German (Ingersoll, 1889).

Prior to this time, most canning establishments for Gulf coast oysters were centered around Mobile, Alabama (Zacharie, 1897; 1898). It was reported that about $100,000 worth of New Orleans canned oysters were marketed in 1880, but even the majority of these were consummed locally. A major hinderance to such operations, however, was the difficulty of obtaining sufficient oysters on a regular basis. This difficulty was attributed to the "indisposition of the oystermen to work in bad weather" and to the event of crevasses that destroyed most oysters destined for nearby canneries (Zacharie, 1897; 1898; Bolinger, 1892). If such difficulties could be overcome, the canning operations had the capacity to increase their output and supply the oyster trade for the Lower Mississippi River Valley and points west (Moore, 1897).

A comparison of conditions in the Louisiana oyster industry for 1880 and 1890 indicates a number of changes over this period of time with regard to expansion of the industry's size and distribution. While accurate, comparative statistics regarding growth of the oyster industry are sparse, and often appear misleading, one government report (Collins and Smith, 1891) on Gulf fisheries serves to illustrate changes that occurred during this decade. For example, Table 5 reveals a phenomenal increase in persons employed and capital invested in Louisiana fisheries in general. During this period, the value of the fisheries products harvested increased by 68.14 percent (Table 5). Of this amount, oysters constituted 45.43 percent of the value of the product of Louisiana fisheries and 28.34 percent of the quantity. The increase in number of bushels harvested between 1880 and 1890 amounted to 65 percent while the value increased by 65 percent (Table 5).

Despite the phenomenally large increase in oyster production, the report still stated that "Louisiana has important undeveloped fishery

Table 5

Comparison of 1880 and 1890 Data Concerning Employment, Capital Investment, Value and Amount of Fisheries Products and Oysters

| DATE | PERSONS EMPLOYED | CAPITAL INVESTED ($) | VALUE OF LOUISIANA FISHERIES PRODUCTS ($) | VALUE OF LOUISIANA OYSTERS HARVESTED ($) | AMOUNT OF LOUISIANA OYSTERS HARVESTED (Bushels) |
|---|---|---|---|---|---|
| 1880 | 1,597 | 93,621 | 392,610 | 118,000 | 295,000 |
| 1890 | 4,068 | 719,867 | 660,134 | 229,896 | 841,585 |
| Change | +2,471 | +626,255 | +267,524 | +181,896 | +546,585 |
| % Increase | + 155 | + 669 | + 68 | + 61 | + 65 |

(Collins and Smith, 1891).

resources among which the oyster is chief" (Collins and Smith, 1891). The report went on to say that:

> The possibilities of the region in the matter of oyster production and cultivation are believed to be great, though there are in some localities certain difficulties to be encountered and natural limitations which may somewhat retard rapid development.

Another Federal report (Zacharie, 1897; 1898) pertaining to the oyster industry indicated that there had been some changes since the early 1880s, but things could be improved. Speaking in regard to the natural resources, Zacharie (1898) was reported as saying:

> The extent of the oyster territory is so vast, the supply so abundant and cheap and so little labor and capital are required for its development, that its wonderful advantages and enormous profits once known, capital and labor will favorable seek employment in what must eventually become a leading industry, far surpassing that of any other State in the union in this respect.

While New Orleans remained the primary market for locally cultivated oysters, especially the counter-stock trade, other areas emerged capable of handling some of the raw-shop and cannery trade. The primary centers for canning either raw or steamed oysters in Louisiana were in Morgan City,

and Houma. Out of state canneries in Biloxi and Bay St. Louis also dealt in Louisiana grown oysters in the late 19th century. Generally, the cost of transportion and the shortage of time before the cargo spoiled, necessitated shipment to the nearest shucking houses. Because of this, canneries and shucking houses located in Morgan City and Houma developed in response to the growing demand for oysters and to receive oysters harvested between South West Pass and Timbalier Bay. Some oysters tonged from Barataria Bay also went to these markets, but most were shipped to New Orleans (Moore, 1898).

Many of the oysters taken from Mississippi Sound and Chandeleur Sound and along the fringes of the Louisiana Marsh were shipped to canneries along the Mississippi Gulf coast (Zacharie, 1898, 1897). It was reported that, by the 1890s, a fleet of lumber schooners, capable of carrying 1,000 to 2,000 barrels of oysters, was effectively combing the oyster beds in St. Bernard Parish and transporting Louisiana oysters to Mississippi canneries (Zacharie, 1898; 1897).

At that time, Louisiana lacked an effective enforcement agency to prevent Mississippi oystermen from poaching on Louisiana oyster reefs. This was a difficult practice to monitor since Mississippi had more canneries than New Orleans or anywhere else in Louisiana and provided a readily available market for oysters that Louisiana could not handle at that time. Even as late as 1910, New Orleans was considered to have a potential but not an actual value as a shipping center for oysters (Kellogg, 1910). This was partially due to the fact that many canneries in Louisiana were frequently forced to relocate to other areas along the coast due to crevasses that killed locally available supplies of oysters. Oysters in the vicinity of the Louisiana Marsh were seldom killed by fresh-

water crevasses, and they were located closer to Mississippi canneries than to Louisiana establishments. Some of the canneries eventually relocated in Mississippi and Alabama where crevasses were not a constant threat to locally available oyster supplies and where good rail lines connected them to distant market centers. New Orleans was slow to develop because one of the most prolific oyster producing grounds, the Louisiana Marsh, was closer to canneries in Mississippi than to those in New Orleans, thereby resulting in unfair competition as long as those oysters could be transported out of the state.

By the turn of the century, Louisiana had started to develop out of state markets even though many oysters were still consumed locally or in other states along the Gulf coast. The principal out of state markets were in Cincinnati, St. Louis, Kansas City, Denver, Louisville, Chicago, St. Paul, Memphis and Natchez (L.S.M.S., 74 A). While it was difficult to compete with Atlantic coast oysters for Northeastern markets due to the distance involved and the superior reputation of Atlantic coast oysters, many felt that Louisiana oysters had an advantage in some of the as yet undeveloped western markets. Moore (1897) in discussing the oyster problem in Louisiana stated that:

> Westward of the Mississippi, the Gulf States can compete on equal or superior terms, so far as distance is concerned, with any of the great oyster markets of the East. Geographically, therefore, they are favorably situated with regard to 80 percent of our territory and 40 percent of our population than are the states of the North Atlantic coast.

By the turn of the 20th century, one company (A. Booth Packing, Co, Morgan City), in order to overcome the poor reputation of Louisiana oysters in out of state markets, shipped its oysters to agents in Cincinnati, Indianapolis, Chicago, Kansas City, and Denver. At these

centers, its agents repacked the oysters and marketed them as Baltimore cove oysters. This served the dual purpose of avoiding Louisiana's bad reputation while capitalizing on Baltimore's good reputation for excellent quality oysters (L.S.M.S., 74A). Part of the reason for Louisiana's low standing on the national market is the fact that, by the turn of the century, most of the best oysters were consumed locally while only the poorest and cheapest quality were exported (Zacharie, 1897; 1898). In some instances, poor quality oysters were bloated prior to shipment and in other cases, some of the early canning practices were inadequate, resulting in oysters with an "unpleasant and 'woody' taste" (Zacharie, 1897).

## Legislation Fostering Development of Louisiana's Oyster Industry

Major growth and expansion of the oyster industry in Louisiana was closely related to state legislation that regulated the industry, promoted private enterprise and protected the natural resource. This legislation came in response to demands of industry spokesmen in the late 19th century who saw the need for regulation of the industry and preservation of a natural renewable resource--the self perpetuating oyster reefs. Steps were taken to regulate the industry relatively soon after it began to expand around the 1860s, largely in response to disappearance of natural reefs in the lower delta near New Orleans. However, in terms of the rest of the nation, especially the North Atlantic States, oyster legislation emerged late in the 19th century.

The lag in establishing oyster legislation is related to three primary factors that distinguished Louisiana from other major oyster producing

areas. First, the amount of oyster growing grounds in the state (estimated at about half a million acres) were larger than the sum total of comparable areas in all the rest of the nation's oyster producing states (Kellogg, 1910; Payne, 1920). Second, high growth and reproduction rates maintained an enormous supply of oysters despite the increasingly heavy fishing pressures. This was made possible by the state's geographic location in a subtropical environment, with warm temperatures and its physiographic components of a broad, highly productive coastal marsh zone with extensive shoreline and numerous shallow streams and embayments. The combination of thes conditions resulted in an extended spawning and growing season and a rapid rate of replenishment of harvested stock. The rapid rate of replenishment and the enormous oyster growing territory permitted wide scale growth and expansion of the industry before conflicts emerged between different oyster interests which necessitated legislation.

The third major reason for the late enactment of oyster legislation can be attributed to the fact that the oyster industry in Louisiana developed later than elsewhere. Despite the enormous amounts of oysters, the industry could not expand until there was sufficient market demand either locally or nation-wide. In general, the local market demand in the 19th century along the southern Gulf coast was relatively small due to the sparse, scattered population and the absence of large cities. As refrigeration and canning processes improved and transportation networks expanded in the early 20th century, new markets became available and the industry was spurred on to supply the demand.

The extensive oyster grounds, high growth and reproduction rates and limited market demands provided the opportunity for the industry to become established before the natural resource was depleted. These three

factors provided the state legislature and informed oystermen with time to recognize their valuable renewable resource, to see how it could be destroyed by unwise fishing practices and lax legislation, and to initiate steps to protect the resource at the same time that it was promoting the industry.

As the industry expanded and more people became involved, especially those of national or ethnic origins other than Slavic, conflicts and controversy arose especially over the acquisition of seed from public grounds. Some of the earliest demands for legislation to protect natural reefs was aimed, not only, at the implementation and enforcement of a culling law but also the prevention of foreigners (or unnaturalized persons) from molesting the reefs of Barataria Bay (Dennett, 1883). While virtually everyone tonged a boatful of reef material including oysters, and culled only after setting sail for home, the foreigners, especially the Slavonians were singled out for blame in the destruction of reefs. They consistantly and systematically removed not only marketable oysters but also smaller seed for transplanting. This deprived other fishermen, usually non-Slavonians, who fished mostly for marketable oysters, of a source of next year's crop (Moore, 1898). Controversies such as this were not solved until a workable set of regulations and an enforcing agency were instituted in 1902. At that time, the State assumed regulation of the industry under the State's first comprehensive oyster law and provided the legal framework for expansion of the industry and preservation of the renewable natural resource upon which it was based.

## Initial Legislation

By 1870, some oystermen had noticed a decline in productivity of

oyster reefs near New Orleans. These reefs had been supplying the city's markets for the longest period of time, and those along the lower delta were declining due to overfishing and changing environmental conditions (removal of reef substrate and salt water intrusion). In an effort to halt the decline, the legislature passed Act 18 in 1870. This legislation was minimal in that it contained only two main provisions with no effective means of enforcement. First, it established a closed season from April 1 to September 15, thereby prohibiting extraction of oysters from Louisiana waters during this period. Second, it established penalities for harvesting oysters during the closed season (Payne, 1920).

The act was amended in 1871, by Act 19. It revised the closed season to include the period between May 1 and September 15. Shortening of the prohibited season was apparently in response to opposition from local oystermen who wanted a longer fishing season. However, this legislation was not effectively enforced and the destruction and depletion of natural reefs continued (Payne, 1920).

Objections to the Initial Legislation

By the early 1880s, a concern was growing within the industry that "with the present wasteful system of collecting and marketing oysters the supplies may be cut short and oysters may become an expensive luxury in a few years" (Dennett, 1883). It was further reported at that time that local oystermen had formulated certain opinions which they wished the State Legislature to act upon. Five specific requests attributed to these men and apparently aimed at governing only the harvesting from natural reefs were (Dennett, 1883):

> 1) ...that citizens not naturalized be prevented from molesting these oyster fields, as a large number of such did some years ago, to the great detriment of

the oyster interests, and which produced what is called the "oyster's war" on Barataria Bay,

2)....that the oyster reefs be free to all, but that all oystermen, when they cull their oysters for market, be compelled to leave the young oysters on public reefs where they get their supplies,

3) ...that reefs where oysters have become scarce be allowed to rest until they have time to recuperate and new crops have time to grow,

4) ...that no one be allowed to take oysters to market from the public reefs between the 15th of April and the 15th of September, which covers the spawning season; but that they be allowed to do so as they please with oysters from their own beds in limits properly defined by stakes, and

5) ...that the best features in the oyster laws of Maryland, Virginia and of other coast states could be adopted by the Louisiana Legislation in constructing a law for this state.

Revision of Previous Legislation

In an attempt to further protect and promote the industry and stem the destruction of natural reefs, the Louisiana State Legislature passed Act 206 in 1886. This act established the fact that the "beds of rivers, creeks, bayous, lakes, coves and sea marshes--all that part of the gulf coast lying within the jurisdiction of the state--should not be sold, but should remain in the possession of the state, to be made into natural oyster beds" (Fortier, 1914). The right of the state to so control her water bottoms had been established earlier by a decision of the United States Supreme Court in the case of James W. McCready vs. Commonwealth of Virginia, 94 U.S. pg. 391 (Payne, 1920). Specifically the Court held that:

1) Each State ownes the tide waters and beds of all waters within its jurisdiction. Subject to the paramount right of navigation, fisheries remain under the exclusive control of the State,

2) A right of fishing is a property right and not a mere privilege or immunity of citizenship,

3) The citizens of one State are not invested by the Constitution of the US with any interest in the common property of the citizens of another State,

4) A State can grant to its own citizens the exclusive use of lands covered by water for raising oysters and may prohibit, under a penalty, their use for such purposes by citizens of other States.

In keeping with this Supreme Court decision and the apparent desire of local oystermen, the legislature enacted the following provisions under Act 206 (1886)(Payne, 1920; Fortier, 1914):

1) a closed season from April 30 to August 15 of each year,

2) leasing of water bottoms not to exceed 3 acres to any one person or corporation,

3) imposition of licenses and taxes on boats and tongmen (the parishes and the state were to divide equally between them half of the net amount obtained from rents, licenses and taxes),

4) fixation of penalities for violation of the law,

5) placement of the regulation of the oyster industry under the absolute control of the local police jury in whose parish it was located, and

6) authorization of the appointment of an oyster commission.

At this time local oystermen were ambivalent concerning private ownership of oyster grounds. On the one hand, they believed that oysters were common property and should be equally available for the taking by everyone. On the other hand, they realized the necessity of establishing and protecting a well defined area for holding oysters that they had collected for marketing. It was in response to this need that the legislature, in 1880, allowed each person to lease three acres. Ostensively, this would enable the individual to protect from theft oysters he had

collected in the process of completing a full load for later transport to market (Mackin and Hopkins, 1962). However, because there is evidence that some attempt at actually transplanting and "cultivating" oysters had been instituted by Slavonians in the lower delta as early as the mid-1860s it is possible that this leasing of private bedding grounds was actually in response to this particular need.

Stronger Legislation in the 1890s

Regardless of the fact that this act (Act 206, 1886), as well as previous legislation, was not judiously enforced, some aspects of the 1886 legislation created difficulties beyond the enforcement problems. In particular, placement of the industry under control of the individual Parish Police Juries resulted in local parishes concluding that oysters within their boundaries were their exclusive property, to be fished only by their citizens. This resulted in frequent confrontations between citizens of different parishes as they crossed parish boundaries seeking marketable oysters and seed for bedding purposes elsewhere.

The year 1892, saw another attempt by the State Legislature to improve upon existing legislation by amending it with Act 110. This act established certain areas (natural oyster reefs) as common fishing grounds open to all Louisiana residents. Most likely, the change grew out of the conflicts between citizens of different parishes over fishing rights and the realization that oystermen had to cross parish boundaries in order to obtain seed or oysters for transplanting on private grounds or for market. This was necessary because environmental conditions vary from parish to parish and from year to year so that oystermen had to constantly seek additional seed supplies and favorable oyster producing areas.

Act 110 of 1892, also increased the size of a lease from three acres to ten acres. The increase was probably made in consideration of the fact that some oystermen were actually cultivating their grounds and it was believed that ten acres was the maximum one man with tongs could profitably mangage to work (Gates, 1910).

Under the Act of 1892, the closed season was again altered, this time to extend from May 1 to September 1. Furthermore, it was designated that oysters could not be harvested by any tools other than ordinary tongs. Also, for the first time a minimum size (3 inches) was required before an oyster could be removed from a natural reef. It was thought that by prohibiting dredging, the reefs could be selectively harvested and only the marketable oysters extracted without killing the remainder. Other harvesting tools such as various dredge types were thought to damage the oysters or to smother them with mud that was churned up via dredging operations. Also, fewer oysters could be harvested with tongs than with a dredge in a given amount of time, therefore, the life of the reef would be extended. Furthermore, by outlawing all dredges those who could not afford a dredge and a large boat to drag it were not placed at a disadvantage in working public reefs.

The Act of 1892, also authorized establishment of the office of oyster inspector to enforce the laws. It was hoped that this enforcement power would eliminate the contempt into which the earlier legislation had fallen (Payne, 1920; Fortier, 1914).

Because there was general disatisfaction with the laws and with their enforcement and because the extent of naturally producing reefs continued to decline, those oft amended Acts were repealed in 1896. A new act (Act 136) was adopted, retaining most of the features of the previous Act but

relieving from taxation oysters bedded on private grounds leased from the state (Payne, 1920; Daily Picayune, 1898). A significant aspect of this act which was to have a bearing on future legislation was its request that the U. S. Fish Commission investigate the biology, distribution, and condition of oysters in the state as well as the extent of its natural producing grounds (Daily Picayune, 1898).

Professional Recommendations

By the end of the 19th century, the state legislature realized that they had to devise an effective program to protect the interests of the state and the oystermen, as well as promote the industry. The previous laws had been ineffective because there was controversy over their supposed purpose and validity and because they were not actively and universally enforced on the state level. The result of past legislation had been continual strife between oystermen of different parishes and depletion and destruction of the natural reefs (Payne, 1920). In summing up the state of the industry in the late 19th century, a local oysterman (Daily Picayune, 1892) said:

> In some parishes the only interest that seems to be taken by the parish officers is to collect the oyster tax and in most parishes even that much interest is not taken.

In response to a request from a state legislative committee in 1897, H. F. Moore, Assistant U.S. Fish Commissioner was ordered to Louisiana to conduct a study of Louisiana oyster bottoms; apparently the first government survey made of the oyster industry in the state. Based on his findings, Moore made nine recommendations to the legislative committee of 1900 which was preparing the oyster law of 1902. These recommendations-(Moore, 1898) were:

1) ...no oysters be permitted to be removed from the natural beds for any purpose whatever during the period from April 15 to October 1,

2) ...no oysters, whatsoever caught, should be sold or exposed to sale within the closed season as fixed in the preceding section,

3) ...it should be illegal to remove from the natural beds, for any purpose whatever, shells or oysters under 3 inches in length,

4) ...all boats or vessels engaged in culling should be at anchor on the natural beds,

5) ...every effort should be made to induce the oystermen to adopt the practice of exposing shells or other cultch for the purpose of catching the spat or young oysters,

6) ...provision be made for granting to the oyster grower permanent tenure of his beds,

7) ...the area which may be purchased or leased by each applicant should be increased from 10 to at least 25 acres, and doubtless it would be good policy to remove the limit entirely,

8) ...a definition be made of the meaning of the term "natural oyster reef or bed" as used in the oyster laws, and that this definition be drawn with due regard to the fact that a reef may cease to be such, either as a result of oystering or in consequence of the operation of purely natural causes,

9) ...the oyster laws might in some places be enforced better, as they certainly would be, throughout the State, more uniformly, if their administration was placed in the hands of a State Fish Commission appointed for that purpose.

In 1900, the State Legislature appointed a committee of five persons (three representatives from the House and two from the Senate) to examine the oyster industry and formulate a bill for its improvement (Payne, 1920). The first meeting was held April 6, 1902, in the law office of John Dymond, Jr. on Carondolet Street in New Orleans. Senator Dymond acted as chairman and the other members present included Senator Hugh C. Cage of New Orleans,

Representative Bonvillain of Terrebonne, Representative Leopold of Plaquemines and Representative Jacobs of St. Mary. In formulating the following recommendations for presentation to the State Legislature, the Committee had consulted laws governing the oyster industry in Mississippi, Maryland, Virginia and Connecticut (Daily Picayune, 1902). Twenty provisions were agreed upon and later presented to the legislature for consideration:

1) ...that the legislature shall create an oyster commission to permanently control the oyster industry of the state,

2) ...that the commission shall consist of five members to be appointed by the governor, one from each of the supreme court districts of the state, except that two commissioners shall be appointed from the first supreme court district,

3) ...that the commissioners shall not be interested financially in the oyster industry,

4) ...that the commissioners shall receive a per diem salary of $10 and traveling expenses when in attendance upon sessions of the commission, and also while coming to the scene of the sessions and returning to their homes,

5) ...that the commissioners shall have full authority to regulate the oyster industry within the lines which shall be determined by law,

6) ...the commissioners shall be authorized to employ a secretary, at a salary not to exceed $1,200 per annum, and who shall give his entire time and attention to his office and employment,

7) ...the commission shall be authorized to employ an attorney at a salary not to exceed $1,200 a year,

8) ...the commission shall have authority to elect a chief inspector at a salary not to exceed $1,000 per annum, and such a percentage of the license fees collected as the commission may allow, provided that his total annual compensation shall not exceed $1,800,

9) ...the commission shall have authority to employ such deputy inspectors, patrolmen and other employees as may be necessary to regulate the industry and to carry into effect the provisions of the law and the rules and regulations of the commission,

10) ...the commission shall have authority to acquire boats, vessels, and such other movable property as may be necessary to carry the law into effect,

11) ...the salaries of the deputy inspectors, patrolmen and other employees shall be fixed by the commission,

12) ...employees shall be bonded as follows: Secretary, $2,500; Chief inspector, $2,500; deputy inspectors, $1,000. The right of the commission to increase the bonds, when such a course is deemed necessary is reserved. The commission may pay the cost and fees of the indemnity bonds but the surety shall not be interested in the indemnity.

13) ...the commission shall establish and maintain the necessary patrol of the gulf coast, and to enforce the police regulations satisfactorily, the boats shall be authorized to carry cannon,

14) ...no oysters shall be sold or given away, nor shall anyone have oysters in his possession for consumption or sale during the closed season,

15) ...the close season shall be May 1 to October 1,

16) ...dredging on natural reefs shall be prohibited,

17) ...dredging on private bedding grounds shall be permitted when in the presence of an inspector of the commission paid by the lessee of the grounds (this provision was not adopted, but left unsettled)

18) ...a tax of 2 cents per barrel shall be levied on all oysters,

19) ...the provision will cover the question of acerage (unsettled),

20) ... all measures calculating the quantity of oysters shall bear the state stamp as to examination, and shall be of official size.

Louisiana's First Comprehensive Oyster Law

In 1902, the Louisiana legislature received the report of the 1900 ad hoc committee which included recommendations for legislation to preserve and promote the growth of oysters and the oyster industry in Louisiana. This, along with the report by H. F. Moore (1898), of the U.S. Fish

Commission, was incorporated into the legislation of 1902 and formed the basis of Louisiana's first comprehensive oyster law (Payne, 1920).

With passage of this Act, the State was authorized to appoint five persons to serve as oyster commissioners. Collectively, the oyster commission was given broad powers, as well as funding, to regulate the industry and to enforce the oyster laws. Their power included the authority to sue and to be sued, to buy, sell or lease property, enact contracts, and to adopt by-laws for its own government and that of its employees. At the time of legislation, the act was subject to review by the courts but in the meantime the commission was granted large appropriations to assemble a force to execute the laws and police the industry. Specifically the Act of 1902 contained the following features:

1) ...set the limits of riparian rights at the low water mark,

2) ...established common fishing grounds in all waters under the jurisdiction of the state but with certain restrictions on their utilization by all Louisiana residents,

3) ...declared that stream beds bordering the Gulf of Mexico could not be sold,

4) ...set a size limit on oysters that could be harvested,

5) ...prohibited the use of dredges on oyster grounds,

6) ...prohibited the shipment of Louisiana oysters to out of state canning companies,

7) ...determined the limits of natural beds that were not subject to private leasing,

8) ...provided for measures to enlarge and care for natural oyster beds,

9) ...enforced private property rights of owners of leased oyster beds, and

10) ...provided means for settling disputes between lessees over legal boundaries of bedding grounds (Kellogg, 1910; Fortier, 1914; Payne, 1920).

In summary, it was stated that the fundamental feature of the Act of 1902, was:

> ...creation of a state oyster commission having sole jurisdiction, in oysters and cognate matters, over the entire coast, insuring consistency and uniformity of administration and endowed with ample police powers to enforce the laws which under the old regime, were disregarded with impunity" (Moore and Pope; Payne, 1920).

The effect of this law was an almost immediate expansion of the oyster industry largely as a result of the protection of private property (i.e. oysters on leased grounds) afforded by the oyster commission and its police force (Moore and Pope, 1910; Times Picayune, 1920). For the first time in Louisiana, private grounds were surveyed by a state surveyor upon the request of the lessee, and the oyster plat was recorded and filed at the Commission headquarters in New Orleans.

The success of this legislation is evidenced by the fact that the number of leases and the number of acres leased increased greatly in the years immediately following the passage of the Act of 1902. Under the old system of parish supervision (between 1885 and 1902), only 521 leases totaling 2,820 acres had been let for the entire state; and many of these had been discontinued by 1902 (Moore and Pope, 1910). With state regulation of the leasing program 223 leases (totaling 2,469.91 acres) were recorded in 1902 (Louisiana Department of Conservation /L.D.C./, oyster plats, 1902). By March 1908, 1,692 oyster leases covering 22,135 acres were in effect (Moore and Pope, 1910).

The increase in production of oysters was as significant as the increase in the number of acres leased. While the production figures for 1897 to 1908 (Table 6 ) may not be completely accurate, Moore and Pope (1910) felt that they indicated important trends in Louisiana's oyster industry and that these trends were closely correlated with the emergence of a

Table 6

Production of Oysters in Louisiana: 1897, 1902-1908

| Year | Product (in bushels) | % Increase Per Annum |
|---|---|---|
| 1897 | 959,190 | - |
| 1902 | 1,198.413 | 5 |
| 1903 | 1,534,000 | 28 |
| 1904 | 1,620,576 | 6 |
| 1905 | 2,187,000 | 35 |
| 1906 | 2,486,256 | 14 |
| 1907 | 3,035,370 | 22 |
| 1908 | 3,600,000 | 19 |

(Moore and Pope, 1910)

comprehensive oyster law:

> The increase between 1902 and 1903 can not be definitely accounted for and may possibly be due to a difference in the method of gathering the statistics, but from 1904 onward the increases are in part due to the fostering of new oyster houses and the care of natural beds, but particularly to the fact that the private oyster bottoms were coming into productiveness. The natural beds of the state still produce in quantity more than the planted beds, but the disparity is yearly becoming less, and in 1908 the value of oysters marketed from planted grounds slightly exceeded that of those derived from natural beds. The quantity produced exceeded the whole product of the state at the time of the investigation of 1898 and almost equaled the yield from all sources in 1902, when the first comprehensive oyster law was enacted.

The Act of 1902, was further ammended in June of 1904, to include the following changes (Fortier, 1914):

1) ...the powers and duties of the oyster commission were more clearly defined,

2) ...commissioners were not allowed to have any personal interests in the oyster industry,

3) ...the salary limit of each commissioner was set at $2,500 with the president permitted an additional $1,000,

4) ...the commission could acquire necessary property and vessels and could spend $5,000 per year to enlarge and improve natural reefs,

5) ...no natural reefs thus improved could be leased to individuals or companies,

6) ... residents of Louisiana could lease oyster grounds outside of natural reef areas by making a written application and paying for a commission survey of the desired ground,

7) ...no lease could include more than 1,000 acres, Leases were good for 15 years as long as a yearly rental fee of $1.00 per acre was paid,

8) ...conditions under which dredges were permitted were defined and the fee was set at $10.00 per dredge,

9) ...vessels used in the oyster industry were required to purchase a police license prorated at $0.50 per ton of vessel,

10) ...when in violation of oyster law, vessels and cargoes could be seized and delivered to parish in which seizure was made; the sheriff could dispose of the cargo, and the vessel could be forfieted and sold with all proceeds going to the oyster commission,

11) ...canning establishments were regulated by a license fee of $100.00 per year and a tax of $0.03 per barrel on oysters canned,

12) ...the position of chief surveyor of oyster grounds was created with an annual salary of $2,500,

13) ...deputy inspectors were authorized with their salary to be determined by the board, and

14) ...a secretary and an attorney were also authorized with a salary of $1,200 each.

In 1910, the oyster law was further amended and the oyster commission was consolidated with the State Game Commission and renamed the Board of Commissioners for the Protection of Birds, Game and Fish. In 1912, this board was renamed the Conservation Commission and in 1916, a reorganization led to the establishment of the Department of Conservation. At this time, all matters pertaining to the oyster industry were handled through the Division of Oysters and Water Bottoms (Payne, 1920). Later, the division was enlarged to Oysters, Water Bottoms and Seafoods, and its function was

expanded to protect, expand and police all marine and fresh-water fisheries of the state. While today the oyster industry is but one concern of the Louisiana Wild Life and Fisheries Commission, it was the first marine resource to be designated for protection and study. The concept of an "oyster commission," first formulated by legislation in the 1870s, represented the first efforts in the state directed toward the control of Louisiana's natural, renewable resources (Ford, 1968). The Louisiana oyster industry based on this renewable natural resource did not become well established until an effective means was established via legislation and enforcement to preserve the natural productiveness of the resource and to promote the right of private enterprise through recognition of private oyster grounds.

# CHAPTER V

## AREAL EXTENT AND DISTRIBUTION OF THE OYSTER INDUSTRY IN 1902

The state of Louisiana, through a legislative Act of 1886, gave individual parishes the right to regulate the oyster industry in their parish. In keeping with this mandate, several parishes did lease oyster grounds upon request. However, no more than a few hundred leases were recorded before the turn of the 20th century (Moore and Pope, 1910; Dymond, 1904).

In 1902, the state of Louisiana reevaluated their oyster legislation and in the process established new policies with regard to the industry. A major reform that was to prove vital to the growth of the industry was the policy of state administration of surveying and leasing oyster grounds to private citizens upon their request. During the first year (1902) of leasing, approximately 223 persons, in five out of the nine parishes where oysters grew naturally applied for oyster leases (Fig. 27; Appendix 4).

Each oyster plat was given a number according to the order in which the lease was requested, surveyed and recorded. All oyster plats contained the name of the lease owner, the size of the lease, the parish where it was located and a sketch showing its exact configuration and location. Some plats had additional information such as the number of boats and tongers being used on the leased ground, any previous lease numbers for that particular area, and any ownership transferals. An analysis of this information provides an insight into the ethnic origins of oystermen, a knowledge of where the oyster cultivation practices were concentrated, the area where desirable and suitable grounds lacking viable reefs were located, the type of activity occurring on a particular lease and the order in which oyster leases were requested.

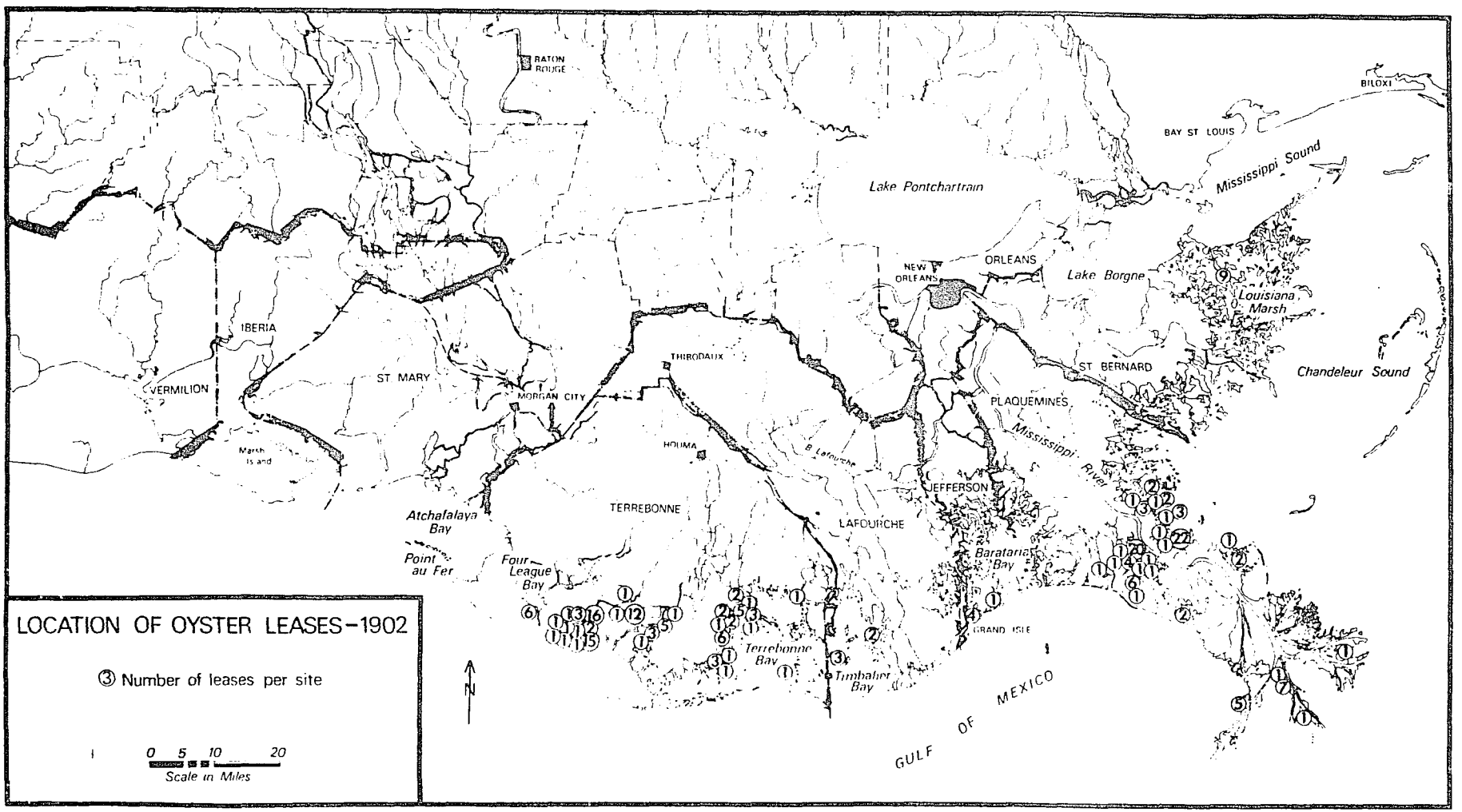



Fig. 27 Map of the distribution of oyster leases recorded in 1902 by the Louisiana Department of Conservation.

## Distribution of Oyster Leases in 1902

Of the nine parishes capable of growing oysters in the early 20th century, only five recorded oyster leases during the first year of state controlled leasing. These five parishes were located in the Mississippi River deltaic plain between the Louisiana Marsh and Point au Fer and included St. Bernard, Plaquemines, Jefferson, Lafourche and Terrebonne. Leasing probably was not undertaken in the remaining four parishes for several reasons. First, the coastal populations of Cameron, Vermilion, Iberia and St. Mary were small and there were no major oyster market centers to purchase large quantities of oysters thereby justifying the cost of cultivation. Second, two of these parishes, Cameron and Vermilion, were in the chenier plain region where riverine transportation routes into the interior towns were virtually non-existent. This made transport to even the smallest markets expensive and slow. Furthermore, there were few estuarine embayments in the chenier plain suitable for extensive oyster production.

Third, in contrast to Vermilion and Cameron Parishes, St. Mary and Iberia Parishes were located in the deltaic plain but were on the site of some of the earliest abandoned deltaic lobes, Lafayette, Maringouin and Sale-Cypremort (Fig. 3). Extensive erosion had removed the shallow, protected, estuarine embayments and tidal channels and created large inter-connecting bays with soft mud bottoms unsuitable for oyster growth. The Vermilion to Atchafalaya Bay complex was also an unstable oyster growing environment because it was subject to frequent and massive fresh-water flooding via the Atchafalaya River. Oyster strikes may have been frequent in the late 19th and early 20th centuries, but the oysters were killed by seasonal flooding if not removed to estuarine environments with

more stable year-round salinities. Fourth, because of the sparse population engaged in oystering, the long distance to market, the low demand for legally protected oyster grounds, persons oystering in these areas may not have felt the need to lease private grounds from the state during the early 20th century.

A comparison of statistics for the five parishes reporting lease data in 1902 gives an indication of the growth and position of the oyster industry in Louisiana at the turn of the 20th century (Fig. 27 ; Table 7).

Table 7
Statistics on Oyster Ground Leases in Louisiana in 1902

| Parish | No. of Leases | Acres Leased | Avg. Size of Lease |
|---|---|---|---|
| St. Bernard | 9 | 160.00 | 17.8 |
| Plaquemines: | (97) | (925.08) | (9.5) |
| East of River | 40 | 463.05 | 11.6 |
| West of River | 38 | 354.29 | 9.3 |
| Mouth of River | 19 | 107.74 | 5.6 |
| Jefferson | 6 | 60.00 | 10.0 |
| Lafourche | 5 | 50.00 | 10.0 |
| Terrebonne: | (106) | (1,281.83) | (12.0) |
| Terrebonne Bay Area | 29 | 344.83 | 11.9 |
| Caillou Lake Area | 74 | 917.00 | 12.4 |
| Other | 4 | 20.00 | 6.6 |
| Total: | 223 | 2,469.91 | 11.8 |

(Source: Louisiana Department of Conservation, oyster plats, 1902)

## Ethnic Origin of Early Louisiana Oystermen

A review of surnames listed on the oyster plats indicate that there were primarily six ethnic groups represented in the industry at the time (Table 8). The largest percentage of oystermen statewide appear to be English, French and Slavonian. On a parish basis, English and Slavonian oystermen held the majority of leases in Plaquemines. In

Table 8

Relationship Between Leases in a Parish and Ownership According to Ethnic Surname

| Ethnic Surname | Plaquemines No. | % | St. Bernard No. | % | Jefferson No. | % | Lafourche No. | % | Terrebonne No. | % | Total No. | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| English | 31 | 33 | 6 | 67 | 1 | 17 | 0 | 0 | 40 | 38 | 77 | 34 |
| French | 15 | 15 | 1 | 11 | 2 | 33 | 2 | 40 | 43 | 40 | 63 | 28 |
| German | 11 | 11 | 1 | 11 | 0 | 0 | 0 | 0 | 8 | 7 | 20 | 9 |
| Slavonian | 21 | 22 | 0 | 0 | 0 | 0 | 1 | 20 | 4 | 4 | 26 | 12 |
| Italian | 12 | 12 | 0 | 0 | 3 | 50 | 1 | 20 | 7 | 6 | 23 | 10 |
| Spanish | 4 | 4 | 0 | 0 | 0 | 0 | 1 | 20 | 5 | 5 | 10 | 5 |
| Unknown | 3 | 3 | 1 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 |
| Total Leases | 97 | 100 | 9 | 100 | 6 | 100 | 5 | 100 | 106 | 100 | 223 | 100 |

(Source: Louisiana Department of Conservation, 1902)

St. Bernard Parish, most of the leases were held by persons with English surnames. In Jefferson Parish, Italians had the most leases while the French had the largest percentage of leases in Lafourche. The majority of leases in Terrebonne Parish were about equally divided between persons with English and French surnames. This breakdown of number of leases by ethnic surnames indicates that the major lease holders in each parish corresponded rather closely with the concentration of a particular ethnic group within the parish. However, these data indicate ownership only and do not adequately portray the actual number of persons by ethnic origin working in the industry. It is quite possible that wealthier individuals leased ground from the state and then hired other ethnic groups to work their grounds.

## Environmental and Cultivation Conditions Evidenced by Lease Data

The large numbers of leases requested in Plaquemines and Terrebonne Parishes attest to the fact that these areas had the largest expanse of bottoms suitable for oyster cultivation. By the time state leasing occurred, most of the natural reefs in Plaquemines Parish had already been destroyed (Fig. 10). Because viable reefs were not present such

areas were available for leasing. While extensive reefs still remained in Terrebonne Parish (Fig. 10) and were therefore not subject to leasing, there were still enormous areas of firm substrate in the upper reaches of Terrebonne Bay and along the shorelines of the tidal channels and embayments tothe west of Terrebonne Bay that could be leased (Moore, 1898). Both of these parishes had major market facilities that encouraged cultivation in the vicinity. By 1902, oysters cultivated in Terrebonne Parish could be sold around Houma and Thibodaux, while those in Plaquemines Parish were shipped to New Orleans.

Terrebonne Parish contained the largest number of leases (106) recorded by the state in 1902 (Fig. 27; Appendix 4). Approximately one third of the leases was located along the northwestern shores of Terrebonne Bay east of Bayou Petit Caillou and north from Lake Pelto to the western edge of Lake Barre. The remaining two thirds were located in the vicinity of Caillou (Sister) Lake stretching from Bayou Grand Caillou to Bay Castagnet. The greatest concentrations of leases were in Caillou Lake (12 leases), Mud Hole Bay (16 leases) and Jack Stout Bay (15 leases). The size of the leases were about the same in both locations (Table 7) with those around Caillou Lake being slightly larger than leases elsewhere in Louisiana.

During the first year of state leasing, none of the grounds in Terrebonne Parish were recorded as belonging to companies. However, information contained on the plats indicate that five of the leases (135, 149, 162, 168, 180) located in Caillou Lake were later incorporated into the holdings of the Pelican Lake Oyster and Packing Company. Previously, they had been held briefly by the St. Martin Oyster Company.

In a number of cases (59), between two and four leases were listed

as belonging to persons with the same surname. In some cases, a man would hold one lease in his name, one in his wife's and possibly one or more in his children's or a relative's name. This was an attempt to circumvent the existing state laws limiting the number of acres one person could hold.

Approximately one third of the oyster leases in Terrebonne Parish in 1902, was in the vicinity of Terrebonne Bay. Moore (1898) had noted that in 1897, approximately 15 men planted oysters in Terrebonne while about 17 planted in bayous and bays westward of this area. He further noted that the number of planters was on the increase and that fifty applications for new leases were pending at the time. This would make a total of 82 leases, only 24 less than the number of leases recorded by the whole parish in 1902. However, it should be noted that during the same time period, Moore (1898) mentioned that there were about 500 men planting oysters in the Bayou Cook area. Although Terrebonne Parish had the potential to become a major oyster producing area for Louisiana, because of its extensive amount of suitable ground and abundant seed supply, it was the Bayou Cook area that actually possessed the most intensive oyster industry at the turn of the 20th century.

Most of the planting in this area consisted of transplanting seed from the natural reefs in the bays into more protected smaller bays and bayous near oyster camps (Moore, 1898). Few shells were planted as cultch to collect spat, even though Moore (1898) indicated that it would have been easy to obtain shells from the 100,000 barrels piled around Houma's oyster canneries northwest of Terrebonne Bay. While Moore (1898) deplored the lack of cultch planting during his early investigation, he later discovered that this was not a suitable practice every-

where in the area due to heavy destruction from predators such as the oyster drill (Moore and Pope, 1910).

Moore (1898) further noted that there were several bedding grounds in Pelican Lake, southwest of Terrebonne Bay, and that planting had also been in progress in Lake Chien for about five years. However, no state surveyed leases were recorded in this area in 1902. In the former lake, drum were troublesome and beds had to be protected by fences, while both drum and drills were major pests in Lake Chien. The presence of drills indicated salt water intrusion and would naturally decrease the use of the area for cultch or small seed planting.

Westward of this area, in the vicinity of Caillou Lake, Moore (1898) noted that several men were planting oysters in Bayou de Large. In Caillou Lake itself, several men, who were harvesting from the natural reefs, also had small planting grounds. Later investigations (Moore and Pope, 1910), indicated that salt water intrusion and predation by drills had become a problem in the lower reaches of Caillou Lake.

Jack Stout Bayou and Bayou Provincial southwest of Caillou Lake were described as "the best oyster-planting grounds in the vicinity...as... the oysters get very fat there early in the season" (Moore, 1898). Seed for replanting in the area was obtained from Lake Washa (Mauchas or Mechant) and from Big and Little Bays Genoble. Moore (1898) further commented that before oysters from these areas can be marketed, they have to be replanted on hard, clean bottom for three to seven days in order for them to purge themselves of dirt. Since he did not make this observation concerning oysters planted elsewhere in Louisiana, this may indicate that the area had a higher sediment concentration in the water that caused the oysters to ingest excessive quantities making them unpalatable when eaten.

There were a number of major environmental factors influencing the distribution of these early leases in Terrebonne Parish. First, for the most part, the leases were located on hard mud bottoms or formerly productive reef bottoms in protected areas such as coves, bayous or small lakes. Second, they were in estuarine environments where fresh-water from inland runoff and saline Gulf water mixed. Few leases were in the Gulf or inland where fresh-water conditions predominated year-round. In addition to problems associated with too high or too low salinities, either of these types of salinity regimes would support a host of predators or competitors that either destroyed the oysters are made harvesting them more difficult. For example, Lake Felicity northeast of Lake Barre contained numerous oysters, but due to fresher water conditions, mussels were quite abundant making culling of the harvested oysters difficult. This was also noted as a problem common to some of the reefs in Caillou Lake.

Conversely, southwest of Caillou Lake in Bay Voison, drills were noted as being an increasingly common problem, indicating that salt water intrusion was occurring. Salt water was moving northward into the upper reaches of Terrebonne Bay as the marine processes were eroding the abandoned delta lobes. Moore (1898) in describing the area mentioned the following conditions:

> It is stated that fifteen years ago there were no oysters above Bayou Lagraisse, none in some of the small bayous or Lake Barre,... The topographical changes in the region between Timbalier and Terrebonne bays are quite extensive and rapid, and islands were observed there in all stages of destruction, some of them cut into pieces, others barely showing above the water, and still others whose former positions were marked merely by shoals or by dead brush projecting above the surface. It appears probably that these changes might have produced considerable alteration of the hydrographic character and thus have changed the adaptability of the waters for oysters.

In summarizing the oyster growing conditions in Terrebonne Parish, it appears that major oyster planting areas were located in the northwest portions of Terrebonne Bay and in the vicinity of Caillou Lake. Most activity was in the estuarine environment where waters were neither too fresh nor too saline and where predation or competition was not pronounced. For the most part, planting involved transferring seed from natural reefs to bedding grounds which were sometimes fenced to prevent predation from drum. Planting of cultch was not prevelant despite the abundance of shell in several locations near the major planting grounds. Extensive fishing of the more limited oyster reefs by oystermen, some from as far away as Bayou Cook, had depleted the natural reefs in a few areas that had formerly been very productive. However, the total area suitable for oyster growing was still larger than elsewhere in Louisiana, because marine erosion of the coastal areas and salt water intrusion into interior bays and bayous had opened up new areas suitable for oyster growth permitting the total amount of oyster growing areas to remain fairly stable.

Plaquemines Parish possessed the second largest number (97) of leases recorded in 1902. Forty were located east of the Mississippi River, 19 were at the mouth of the river and 38 were west of the river (Fig. 27). East of the river the majority of leases (22) were located along the shores of Quarantine Bay. Thirteen of the leases contained acres each, while the remaining nine, each covered 20 acres of water bottom. Fifteen leases were located along the coast northwest of Quarantine Bay within a few miles of the bay. All of these leases were relatively small in size ranging from 1.8 acres to 12.25 acres. The average size was 9.2 acres, less than the 20 acres which the state allowed one person to lease

by 1902.

The only other cluster of leases was in Grand Bay (two leases) and Coquile Bay (one lease) about five to ten miles southwest of Quarantine Bay. These leases were also small in size being 8.3, 5.36, and ten acres respectively and averaging 7.55 acres. The leases recorded east of the river in 1902, are in the general vicinity of some of the earliest planting grounds in Louisiana (Moore, 1898; Vujnovich, 1974; Pausina, 1970; L.S.M.S., 74A).

While each oyster plat form requested the number of tongers and boats to be used on the leased ground, only 13 leases recorded any tongers and only ten noted boats. All leases were located in the lower Mississippi River delta. Ten of the leases (51, 52, 54, 4, 30, 31, 32, 33, 36, 38) showing tongers affiliated with grounds were located east of the river (Table 9). The fact that tongers and boats were recorded on some leases in the lower delta may indicate that the lease owners hired personnel to work the grounds either with them or for them.

Furthermore, all but one of the leases east of the river employing tongers were considerably larger than those located west of the river. This, plus the fact that four of the eastern leases were held by companies, may indicate that the eastern leases were used primarily for the purpose of claiming a large area for harvest of seed oysters during favorable years, especially in the vicinity of Quarantine Bay. Early biological reports (Gates, 1910) had indicated that ten acres was about as much as one man with tongs could plant and cultivate properly without help.

In contrast, all three leases west of the river that employed tongers were quite small (1.57, 3.00, 9.00 acres) and were held by individuals not companies. In addition, information contained on the plats indicated

Table 9

Number of Tongers and Vessels Listed with Oyster Leases Recorded in 1902

| | Lease No. | Size (acres) | Owner Address | Lease Location | No. of Tongers | No. of Luggers | No. of Vessels | No. of Boats | No. of Skiffs |
|---|---|---|---|---|---|---|---|---|---|
| East of the River | 4 | 5.36 | G. Parun Olga, La. | Grand Bay | 6 | 0 | 0 | 0 | 0 |
| | 30 | 10.00 | Kako & Lintich Ostrica, La. | Quarantine Bay | 2 | 0 | 0 | 0 | 0 |
| | 31 | 20.00 | P. M. Cuselich & Co. Ostrica, La. | " | 2 | 0 | 2 | 2 | 0 |
| | 32 | 20.00 | J. F. Reese Ostrica, La. | " | 1 | 1 | 0 | 0 | 0 |
| | 34 | 10.00 | V. Barrios Buras, La. | " | 2* | 1 | 0 | 0 | 0 |
| | 36 | 12.25 | N. Riquard & Co. Ostrica, La. | Bordolles Bay | 2 | 1 | 0 | 0 | 0 |
| | 38 | 10.00 | C. M. Hingle, Jr. Ostrica, La. | Quarantine Bay | 2 | 0 | 0 | 2 | 0 |
| | 51 | 10.00 | C. Anderson Ostrica, La. | Anderson Bay | 1 | 1 | 0 | 0 | 0 |
| | 52 | 20.00 | Marinovich & Co. Ostrica, La. | Quarantine Bay | 2 | 0 | 0 | 0 | 0 |
| | 54 | 10.00 | L. Benen Nicholl P.O., La. | Caspar Bayou | 1 | 0 | 0 | 1 | 0 |
| West of the River | 18 | 1.57 | A. Rudolf Empire, La. | Bayou Cook | 1 | 0 | 0 | 1 | 0 |
| | 64 | 3.00 | P. Yuratich Buras, La. | Bayou La Chute | 2 | 0 | 1 | 1 | 0 |
| | 68 | 9.00 | J. Dymond Jr. Empire, La. | Bay Adam | 1 | 0 | 0 | 0 | 0 |

* 2 luggermen

(Source: Louisiana Department of Conservation, 1902)

that these leases were used specifically as bedding grounds. Lease number 68 (nine acres) in Bay Adam was incorporated with nine other leases in the vicinity and placed under operation of the Dymond Island Oyster Company, Ltd. in 1904. This move was possible because the legislature in 1904, increased the limit of an oyster ground's size of 1,000 acres for companies.

While approximately the same number of leases were recorded on both sides of the river in 1902, the average size of leases west of the river was less than those to the east (Table 7). On both sides of the river, companies controlled the majority of leases totaling 20 acres (six out

of nine on the east and six out of ten on the west). However, while four of the 23 leases of ten acres were company controlled on the east, only four leases on the west covered ten acres and none were company controlled.

Perhaps the greatest contrast between leasing conditions on the east and west sides of the river can be seen in the difference between the number of leases amounting to less than ten acres in size. East of the river, only seven leases were less than ten acres (averaging 5.68 acres) while on the west, 21 leases were larger than one acre, but less than ten acres (averaging 4.16 acres), and three leases were less than one acres in size (averaging 0.58 acres). This indicates that a great number of oystermen were applying for leases in an area in which the total area of desirable oyster growing bottoms was small.

All but two of the state granted oyster leases recorded west of the river in 1902, were within about a four mile radius of Bayou Cook, the most famous and longest established oyster producing region in Louisiana. At this time, all favorable bottoms had been acquired by private interests. However, a number of acres remained unclaimed due to the soft nature of the bottom and because no attempt was made to improve it by depositing shells. The center of the channel was also unsuitable and not likely to be improved because it consisted of sand which was capable of shifting during storms and burying the planted oysters. In 1893, such an event happened when a storm buried thousands of oysters under sand. Moore (1898) commented on this event by inferring that some of the local oystermen lacked an adequate knowledge of oyster culture techniques with regard to oyster planting in an area with a sandy substrate.

It should also be noted that this storm was in fact a hurricane which devastated not only the oyster grounds but also the settlements in the marshes, killing over 200 Slavonian inhabitants. Many of the surviving immigrants left the marshes and resettled in communities such as Empire, Buras and Olga along the higher levees but continued to work their grounds. Others left the marshes and moved to New Orleans, Biloxi, and Bay St. Louis to undertake a new trade unassociated with oyster planting (Vujnovich, 1974).

Leases in the lower delta were smaller than those above Head of Passes. They ranged from 3.0 acres to 12.27 acres and averaged 6.7 acres in size. Only six leases were ten acres or more in size; one was 12.27 acres and six were five acres each. Despite the small extent of suitable oyster bottoms, or perhaps because of it, these oyster leases sold for a rather high price around the turn of the century. A bill of sale attached to lease 59 (in Whale Bay) indicated that it sold for $3,000 per 12 acres in 1912, while 97 (in Mullet's Bayou) consisting of 3.04 acres sold for $500 in 1906. No mention was made of other articles being part of the sale, therefore it is assumed that this price was for purchase of only the oyster grounds.

The overall small size of these leases is due largely to the fact that suitable oyster growing grounds were limited in the lower delta, being primarily confined to the firmer muds along the shores of the interdistributary levee basins. Furthermore, most of these leases were held by individuals and the smaller lease sizes were more condusive to their intensive cultivation techniques of scattering cultch or planting seed. Also, drumfish were troublesome at times, thereby requiring fences around the bedding grounds. This could be done more economically around small plots.

Five of the 97 leases recorded in Plaquemines in 1902 carried

references to the fact that they had been previously held by other owners. These were also the only plats out of all (223) recorded in 1902, that indicated they had been leased earlier from the parish police jury (Table 10). Furthermore, these leases had also been acquired from even earlier owners indicating that oyster ground leasing had been in effect in the area (lower Mississippi River delta) well before the state took over the leasing program.

Table 10

New State Lease Numbers Assigned to Older Parish Leases

| State Lease No. | Former No. or Date | Location | Size (acres) | Owner in 1902 | Prior Owner |
|---|---|---|---|---|---|
| 23 | 1-27-1893 | Whale Bay | 3 | Lobrano & McLaughlin | Whale Bay Oyster Co. |
| c- | 1892 | Bayou Lachute | 3 | P. Yuratich | T. Krilianovich |
| 76 | 2-25-1893 | Bayou Cook | 5 | P. Rihner | J. Frelich |
| 78 | 2-25-1893 | Bayou Courant (Halfmoon Bay) | 3 | J. Frelich | C. Hattor, Jr. |
| 105 | No. 262 | Bay Adam | 12.74 | A. T. Petrovich | A. L. Cibilich |

(Source: Louisiana Department of Conservation, 1902)

All of these leases were in Plaquemines parish with four being east of the River in the vicinity of Bayou Cook and the fifth located in Whale Bay. Furthermore, three of the leases in and around Bayou Cook had been owned by persons with Slavonian surnames, thereby adding more credulance to the statement that Slavonians were prominant in the founding of the oyster industry in the lower delta.

Only nine leases were recorded in St. Bernard Parish in 1902. Because this was a highly productive seed area with many of the firmer bottoms covered with viable oyster reefs, much of this area was not subject

to leasing. A large portion of the remaining bottom was too soft to be suitable for planting (Moore, 1898). The few leases taken in 1902 were in an area that was:

1) at the crossroads between tonging grounds and market collection sites for shipment to New Orleans and elsewhere on the Mississippi coast and
2) conducive to allowing oysters to "fatten" quickly, thereby appearing more desirable when marketed (Moore, 1898).

Continuous use of the area around Pirate Point (Fig. 9) for bedding grounds led to improvement of the substrate by the addition of shell which in turn served as cultch for collection of spat. Deposition of small, unmarketable oysters on this firm substrate also resulted in marketable sized oysters the following season.

It is interesting to note that all of these leases were held by members of the Dunbar family all of whom resided in New Orleans. Furthermore within about one year (by October 12, 1904) all nine leases (totaling 160 acres) were transferred to George Dunbar's Sons, an oyster business. This practice of consolidation of productive oyster grounds appears fairly common throughout coastal Louisiana because at least 32 of the first 223 leases recorded in 1902 were shortly bought out by one of nine oyster companies according to information attached to the first oyster plat records.

The fewest number of leases were located in Lafourche and Jefferson Parishes in 1902. In Jefferson Parish, most of the leases were near Grand Isle where the substrate and amount of spat were suitable but where viable oyster reefs had been extinct for a number of years.

In regard to this portion of the state, Moore (1898) had mentioned several years earlier that:

> ...with one exception not a reef was found which was not extinct from an economic point of view and fast approaching that condition biologically. The exception noted is in Bayou des Islettes, where there are a few fine large oysters in a hole 25 feet deep, where they can not be reached by the tongs of the oystermen.

He further noted that conditions in the upper portions of the bay (Grand Lake, Hackberry Bay, Creole Bay, Bay Batiste) were normally too fresh to ever have permitted growth of extensive oyster communities.

Despite the periodic fresh-water influxes, environmental conditions in the lower Barataria Bay were favorable for oyster production. The lack of the industry in the late 19th and early 20th century was "owing to the extermination of the natural beds and the almost complete neglect of oyster culture" (Moore, 1898). It is possible that this neglect of oyster culture was due partially to the lack of persons residing on Grand Isle with an interest and a knowledge of oyster cultivation. Another possible factor was that this area was far removed from major market areas. The price received for oysters marketed in New Orleans may not have been sufficient to justify the added expense involved in transplanting seed.

For these reasons, at the turn of the century, oysters were largely planted for home consumption around Grand Isle with only one or two men planting for market (Moore, 1898). The small number of oyster leases recorded in 1902, indicate that this area was not a major oyster planting area, with conditions having changed little since Moore's survey six years earlier.

In Lafourche Parish, three leases were located in Timbalier Bay and two were in Jack's (Jacko) Camp Bay. The home address given for each lessee was Cut Off, located along the levees of Bayou Lafourche about 30 miles north of the Gulf of Mexico. These men could easily reach their grounds by traveling along Bayou Lafourche and through a cross bayou

canal into Timbalier Bay. However, either the owners or their help probably lived in camps near the grounds during the height of the oyster season in order to protect their possessions from poachers.

It is interesting to note that although oystering is widespread in portions of Lafourche Parish today, only a few leases were recorded at the turn of the century. There are several reasons that may account for this. First, most of the natural reefs in this area were fished to the point of commercial extinction by the late 19th century (Moore, 1898; Moore and Pope, 1910). Second, while spat was abundant in these waters, there were few suitable places for attachment. Many of the bays and bayous had very soft mud bottoms unsuitable for natural generation of new reef structures. Third, little effort was being made to artificially harden the bottoms for planting of seed oysters. Fourth, planting of cultch material was not common in this area although some was done around Grand Isle in the late 19th century (Moore, 1898). Fifth, most of the people living in the area were of ethnic origins other than Slavonian and probably made their income from sugarcane farming, truck farming or some type of fishing other than oystering. Peoplethat later entered the oyster industry, probably did so at a time when the knowledge of better cultivation techniques had dispersed throughout the coastal zone through contact with the Slavonians who traveled in search of seed oysters or through information furnished by the seed planting experiments of the U. S. Fisheries Service (Moore and Pope, 1910). After the turn of the century, not only was there a better understanding of the methods involved in oyster cultivation, but the price and demand of oysters was sufficintly great to encourage more people to undertake the enterprise.

A review of the lease numbers show that the earliest oyster plats

surveyed and recorded were those in the lower delta close to New Orleans. This indicates that persons in Plaquemines and St. Bernard Parishes were most anxious to establish legal claims to oyster grounds that they may have been leasing from the parishes in earlier years. It is also possible that some enterprising individuals took the first opportunity to legally lease productive oyster grounds in areas where oyster cultivation was already occurring but where the oystermen had not legally leased the ground (L.S.M.S., 74A). It also indicates that being located near New Orleans enabled would-be lease holders to reach the state survey office first to make their claims. The manner in which the leases were recorded indicates that surveys were conducted from east to west with Plaquemines Parish leases being surveyed first and Terrebonne leases being recorded last.

# CHAPTER VI

## SUMMARY AND CONCLUSIONS

Coastal Louisiana is located in a subtropical environment where temperatures facilitate an almost year-round growing season. Runoff from the state's 36,260 square kilometers of wetlands provides abundant organic and inorganic nutrients for high estuarine and marine productivity. These two environmental conditions are fairly constant throughout the coastal zone and are therefore not a controlling factor in productivity. However, other important factors influencing oyster growth and distribution such as salinity and its associated predators, competitors and commensals, substrate and water currents do vary throughout the coastal zone and their values are closely correlated to the stage of a delta cycle. The constant shifting of the Mississippi River across the deltaic plain during the last 12,000 years has created a dynamic environment in which oyster communities have been forced to shift their location in response to changes in the physical environment associated with the delta cycle. The close affinity between oyster communities and certain stages in the delta cycle was recently established when it was learned that Indian shell middens, many with oyster shells being the dominant component, could be used to date a particular delta lobe.

The earliest harvesting of oysters was undertaken by coastal dwelling Indians inhabiting the high natural levees of recently abandoned delta distributaries. Harvesting was done primarily for local consumption with barter or sale to inland inhabitants being very incidential. Early European and American colonists settling in the coastal zone also harvested oysters as a readily available food source high in protein. These early harvests consisted of simple gathering usually by hand on a

small scale without benefit of elaborate equipment. The simple gathering stage characterized the early phases of the oyster industry and continued even into the 20th century.

It was not until the demand for oysters increased in the market places of New Orleans and the small towns that sprang up along the Mississippi River that the oyster industry began evolving into a more systematic enterprise with a division of labor and specialized equipment. This occurred around the middle of the 19th century in the vicinity of the mid to lower Mississippi River delta. There were at least five reasons for the industry developing at this time and in this location:

1) the existence of an abundant and easily harvested supply of oysters,
2) the existence of a dependable and cheap transportation network to the market center,
3) the existence of a dependable market in New Orleans,
4) the existence of merchants in New Orleans willing to grubstake oystermen with supplies and equipment,
5) the existence of a willing and able work force to gather, transport and market oysters.

While simple gathering occurred well into the 20th century in areas where oysters were readily available from public reefs, the process began to give way to cultivation practices around the mid-19th century in the lower delta. There were a number of reasons for this. The reefs in the lower delta had been subject to harvesting for a long period of time and poor but extensive harvesting practices had led to depletion of many reefs to the point of commercial extinction. Also, man-made alterations of the natural drainage regimes as well as seaward progradation of the delta had resulted in less overbank flooding of the adjacent bays and marshlands. The diminished fresh-water discharge plus the dredging of navigation channels connecting interior water bodies with the Gulf,

permitted salt water intrusion. Higher salinities made many areas unsuitable for natural reproduction and regeneration of heavily fished oyster reefs, even though the area remained excellent for growth, fattening and flavoring.

At the same time the environment was changing and the reefs were being depleted, the number of oystermen in the lower delta who were from Dalmatia was increasing. While Dalmatian (Slavonian) fishermen were recorded in the delta as early as the 1830s and 1840s, their numbers showed a marked increase in the 1860s through 1880s. These people came especially to oyster and in the process instituted and improved upon their original oystering experience derived in the old country. Despite diminishing natural reefs, they knew how to cull small reef oysters and plant them on protected oyster bedding grounds so they could increase rapidly in size and fatness. They were willing to travel great distances along the Louisiana coast in search of seed oysters to transplant in the lower delta, especially in the vicinity of Bayou Cook. Their planting efforts resulted in cultivation of the Bayou Cook oyster, the highest quality oyster on the New Orleans market. Other ethnic groups, in contrast, traveled in search of marketable oysters but were slower to undertake planting on privately managed grounds.

The Slavonians were not the only persons associated with early stages of the oyster industry although one in particular, Luke Jurisich, is often called the father of the Louisiana oyster industry. Other ethnic groups such as the creoles, Spaniards and Italians also planted in the lower delta, in Quarantine and California Bays and in the Louisiana Marsh. At the mouth of the delta, Louis Esponger was noted for his pioneering efforts at planting cultch to attract spat and thus obtain a

seed supply after his previous source was destroyed by the Pass a Loutre crevasse of 1892. Regardless of which ethnic group is given final credit for starting the Louisiana oyster industry, there is little doubt that it originated in the lower Mississippi River delta largely because of geographical factors such as the location within easy access to markets and because of environmental conditions such as extensive estuarine environments which were conducive to oyster growth. The lower delta was the primary area in Louisiana to have both the supply of oysters and the demand generated by New Orleans' markets.

As the industry expanded in response to increased demands, the tools required to harvest oysters had to beoome more specialized. Whereas shallow draft skiffs were adequate in the early gathering stages, larger boats were required as the oystermen had to travel greater distances over open water in search of oysters. Until the early 20th century, sailing craft, especially luggers of a Mediterranean style, distinguished the Louisiana oyster fleet from that of other localities. By 1902, the sailing luggers had been replaced by motorized craft. Some steamships were used early in the cannery trade and in the Mississippi and Chandeleur Sounds, lumber schooners capable of carrying 1,000 to 2,000 barrels of oysters bought reef oysters for shipment to Mississippi based canneries.

As the search for oysters moved into deeper waters, tongs and less frequently nippers, were employed to extract oysters. This not only speeded up the harvesting process when compared to hand gathering, but it allowed oystermen to gather oysters from deeper waters during even the coldest months of the year. Hand operated dredges came into very limited use during the late 19th century and were motorized in the early

20th century. At first dredges were prohibited on public grounds and permitted on private grounds only under direct supervision of an oyster inspector. Dredges had the power to revolutionize the industry by making harvesting quicker and more efficient, but they were viewed initially with apprehension. It was feared that mud stirred up by the dredge would smother oysters in the vicinity of dredge operations and that the movement of the dredge across the bottom would kill young, unharvested oysters. Also, it was difficult to control the path of the dredge and when used on private grounds, adjacent owners were afraid the dredge would infringe on their property. Furthermore, dredges had the ability to completely remove all oysters and shells from a natural reef within a very short period of time, thereby placing hand tongers at a disadvantage to those using dredges. For these reasons, in principal, the use of dredges was sharply curtailed in Louisiana waters until well into the 20th century.

An interesting characteristic of the early oyster industry in Louisiana was the dual market system that developed in New Orleans largely as a result of Louisiana's unique coastal geography. The Mississippi River delta was an effective barrier between harvesting activity east and west of the delta. Therefore, for the most part oysters harvested west of the river were shipped up the river to be sold at the French Market in front of the city. A small quantity of oysters grown at the mouth of the river and in bays immediately adjacent to the lower delta were also transported up the river to the French Market. If there were no natural breaks in the lower delta levees, oysters were hand carried in baskets or sacks across the levees to boats waiting in the river.

Oysters harvested east of the river, especially in the Louisiana Marsh and Mississippi and Chandeleur Sounds, were shipped through Lake Pontchartrain to the Old and later the New Basin canals located in back of the city. Since most of the oysters from east of the river were of a lower quality, having been harvested from natural reefs and not given the benefit of even rudimentary cultivation techniques, they were labeled coon or basin oysters and sold at a lower price. While some inferior quality oysters were also harvested from west of the river, virtually all of the cultivated oysters were sold through the French Market, thereby giving this oyster market a higher reputation. In general, oysters reaching the Basin Canals were shucked or steamed and canned for sale for home cooking. Many of the oysters in the French Market, being of the highest quality, were sold raw to be shucked and served on the half shell in oyster saloons and restaurants.

Even as late as the early 20th century, most oysters harvested in Louisiana were consumed locally. Out of state markets were slow to develop for a number of reasons. For a long time, only the lowest quality oysters were shipped out of state, thereby resulting in a poor reputation for Louisiana oysters. Also, packing and canning techniques were often less than adequate and prior to widespread use of refrigeration, many oysters were spoiled by the time they were uncanned. Furthermore, due to the frequent occurrences of natural disasters, such as hurricanes and crevasses, and to the alleged inability to depend on local oystermen for a guaranteed supply of oysters, it was difficult for shippers to guarantee their orders to out of state buyers. Only when these problems were solved in the 20th century did Louisiana develop a nation-wide oyster market.

Legislation governing the oyster industry emerged in 1870 largely in response to requests from some local oystermen who felt unwise harvesting practices were unnecessarily depleting the natural oyster reefs. In the 1880s, more laws were passed but the duty for enforcement was placed with local parish police juries who were often not interested in such matters. One important aspect of the 1886 law was that it permitted private ownership of three acres of oyster bedding grounds. While this was a small amount, it was an initial step allowing oystermen to bed oysters while awaiting market. It also encouraged some oystermen to continue cultivation efforts since it guaranteed the right of ownership to bedding grounds and oysters thereon that were being worked in order to improve their quality.

In the 1890s, more oyster laws were instituted again in response to complaints and conflicts that had arisen within the expanding oyster industry. Common fishing grounds, open to all oystermen were established and harvesting from the areas were restricted to the use of tongs. Also, for the first time a minimum size of three inches was established for all oysters removed from the public reefs and marketed. The area of water bottom that one man could lease for bedding purposes was increased to ten acres and oyster inspectors were appointed to enforce the oyster laws.

By the late 1890s, it appeared that the oyster laws were not effective in preserving natural oyster reefs from extinction. Also, the lack of enforcement had resulted in the laws being held in contempt by many oystermen. At this time, men genuinely interested in promoting the industry petitioned the Louisiana legislature to appoint a committee to investigate circumstances surrounding the industry and to enact laws and

enforcement procedures to protect the renewable resource and promote private industry. The legislature, in addition to appointing an ad hoc committee, requested a Federal survey of Louisiana oyster bottoms in order to determine their extent and condition and to present recommendations for improvement and perpetuation of the resource.

The ad hoc committee of 1900, acting on the basis of their own investigation, in addition to the report of the Federal survey team, made recommendations to the State legislature in 1902. Many of their recommendations were incorporated into Louisiana's first comprehensive oyster law of 1902. This was to remain the basis of all oyster legislation for many years.

The success of this oyster law became apparent very quickly. Only a few hundred acres of private oyster bottoms had been leased under parish supervision between 1886 and 1902 and many of these had been relinquished by 1902. In 1902, under state supervision, 223 leases totaling 2,469.91 acres were granted in five coastal parishes in the eastern half of the state. With the establishment and protection of private ownership of oyster grounds, expansion and improvement in cultivation techniques occurred. Consequently, an increase in the amount of oysters harvested in the early 20th century was attributed to private oyster bottoms coming into productiveness. It was further reported that by 1908, the value of privately grown oysters marketed in Louisiana exceeded that of those harvested from public reefs.

While the state legislature had requested a Federal survey of all Louisiana oyster bottoms in 1896, a complete survey was not made at the time due to the amount of time and money that would have been required to accurately survey such a large area. Rather, Moore (1898) made a

detailed survey of only one area, the Louisiana Marsh, where he located three different types of oyster bottoms: dense, scattered and very scattered. He made a brief reconnaissance to grounds as far west as Four League Bay, making selected sampling runs and interviewing local fishermen regarding the extent and condition of oyster grounds at that time and in the recent past. Information gathered in this survey showed that many formerly productive oyster grounds were commercially extinct due to overfishing, poor fishing practices, especially breach of culling laws, and changes in the environment resulting from both natural and man-made processes. Some formerly prolific oyster areas, such as the lower reaches of Terrebonne, Timbalier and Barateria Bays, were depleted of oysters due to increased salinities and associated increases in predation. This was attributed to two major factors: 1) rapid erosion of buffering marshlands and salt water intrusion from the Gulf associated with advanced stages of deterioration of abandoned delta lobes, and 2) man-made changes in the natural hydrologic regime such as the leveeing of the Mississippi River to prevent annual overbank flooding.

Ploting of oyster leases issued in 1902, showed that either cultivation practices or temporary bedding of collected oysters had spread throughout virtually all of the southeastern portion of coastal Louisiana. The heaviest concentrations of leases were in Plaquemines Parish (97 leases) where cultivation practices were first implemented, and in Terrebonne Parish (106 leases) which was said to be the greatest and most productive oyster region in the state. Leasing was not widespread in either Jefferson or Lafourche Parish where only five leases were issued for each parish in 1902. Few leases (nine) were recorded in St. Bernard Parish in 1902, despite the fact that this parish contained the Louisiana

Marsh, famous for the extensive natural reefs that supplied cannery and seed oysters. A mapping of the distribution of these leases reveals a portrait of the extent of the oyster harvesting industry at the turn of the century. Comparison of this distribution with Moore's (1898) comments on the local environmental conditions and with geographical data on the area show that there was a correlation between oyster distribution as governed by environmental conditions and oyster harvesting during the early stages of the industry.

# BIBLIOGRAPHY


Alford, J. J. (1975) "The ChesapeakeOyster Fishery," The Annals of the Association of American Geographers, Vol 65, No. 2, pp. 229-239.

Anderson, R. and R. C. Anderson (1963) The Sailing-Ship, Six Thousand Years of History, Bonanza Books, New York, New Yor, 212 pp.

Bailey, R. S. (1958) Let's Be Oyster Farmers, Virginia Fisheries Laboratory Education Service, No. 8, 72 pp.

Barrett, E. M. (1962) The California Oyster Industry, California Department of Fish and Game, Fisheries Bulletin 123, 103 pp.

Baughman, J. L. (1948) Oysters Bibliography, Texas A and M Research Foundation, College Station, Texas

_____ (1949) "Potentialities of the Gulf Oyster Industry and Recommendations for Their Realization," Proceedings Gulf and Caribbean Fisheries Institute, Second Annual Session, pp. 55-276.

_____ (1950) "The Texas Oyster Situation," Proceedings Gulf and Caribbean Fisheries Institute, Second Annual Session, pp. 0-11.

Bernard, H. A. and R. J. LeBlanc (1965) Resume of Quaternary Geology of the Northwestern Gulf of Mexico Province, EPR Pub 400, Shell Development Co., Exploration and Production Research Division, Houston, Texas, 68 pp.

Bilich, M. J. (1931) "Louisiana Oystermen," The New Orlenian, Fed. 15, pp. 32-34, 42.

Bouchon-Brandely, G. (1880) "A Report on the Oyster Culture in the Mediterranean," U.S. Commission of Fish and Fisheries Commissioners Report 1880, pp. 907-930.

Brocchi, P. (1884) "Report on the Condition of Oyster Culture in France in 1881," Bulletin of the United States Fish Commission, Vol. IV, No. 7, pp. 97-111.

Brooks, W. K. (1880) Development of the American Oyster, Studies from the Biological Laboratory, No. IV, 1880, Johns Hopkins University, Baltimore, Md., 81 pp.

_____ (1905) The Oyster, A Popular Summary of A Scientific Study, 2nd ed., The John Hopkins Press, Baltimore, Md., 225 pp.

Burkenroad, M. D. (1931) "Notes on the Louisiana Conch Thais haemostoma Linn., in its Relation to the Oyster Ostrea virginica," Ecology, Vol. 12, No. 4, pp. 656-664.

Butler, P. A. (1954) "Summary of Our Knowledge of the Oyster in the Gulf of Mexico," in Gulf of Mexico Its Origin, Waters, and Marine Life,

Fishery Bulletin of the Fish and Wildlife Service, Bulletin 89, Vol. 55, U.S. Gov't Printing Off., Washington, D.C., pp. 479-489.

Byrd, K. M. (1974) Tchefuncte Subsistence Patterns: Morton Shell Mound, Iberia Parish, Louisiana, Thesis, L.S.U., Baton Rouge, La., 191 pp.

Cable, G. W. (1885) The Creoles of Louisiana, John C. Nimmo, Pub., London, England.

Calver, V. (1920) "Oyster Industry--Great Money Getter for People of this State," Times Picayune, May 23, pg. 1, col. 4.

Carson, R. L. (1944) Fish and Shellfish of the South Atlantic and Gulf Coasts, U.S. Department of Interior, Fisheries Conservation Bulletin 37, pp. 3-45.

Cary, L. R. (1904) The Conditions for Oyster Culture in the Waters of the Parishes of Vermilion and Iberia, Louisiana, Gulf Biological Station Bulletin 4, pp. 6-27.

_____ (1907) "The Cultivation of Oysters in Louisiana," Gulf Biologic Station Bulletin 8, pp. 4-56.

Chanley, P. E. (1957) "Survival of Some Juvenile Bivalves in Water of Low Salinity," Proceedings National Shellfish Association, Vol. 48, pp. 52-65.

Chestnut, A. F. (1949)"The Oyster Industry of North Carolina and Some of its Problems," Conservation Addresses National Shellfish Association, pp. 39-42.

Churchill, Jr., E. P. (1920) The Oyster and the Oyster Industry of the Atlantic and Gulf Coasts, Bureau of Fisheries Doc. No. 890, Department of Commerce, Bureau of Fisheries, U.S. Gov't Printing Off., Washington, D.C., 51 pp.

Cibilic, M. (1977) "Experiences of a Croatian Oysterman in Louisiana" (as told to M. Vujnovich) Matica Croatian Emigrants Association Almanac, Zagreb, Yugoslavia, pp. 129-136.

Coastal Environments, Inc. (1977) Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf, Vols. I & II, Interagency Archeological Services, Office of Archeology and Historic Preservation, National Park Service, U.S. Department of Interior, Washington, D.C.

Cole, H. A. (1951) "The British Oyster Industry and its Problems," Conservation

Coleman, J. M. (1966) Recent Coastal Sedimentation Central Louisiana Coast, Coastal Studies Institute, Tech. Rept. 29, L.S.U., Baton Rouge, La.

Collins, J. W. (1892)"Statistical Review of the Coast Fisheries of the United States," Report of the U.S. Fisheries Commission, 1888, Vol. 16, Washington, D.C., pp. 271-378.

Collins, J. W. and H. M. Smith (1891) "A Statistical Report of the Fisheries of the Gulf States," U.S. Fish Commission Bulletin Vol. 2, Washinton, D.C., pp. 93-171.

Daily Picayune (1881) "Oysters," August 31, pg. 2, col. 4.

_____ (1892a) "Protection of Our Oyster Industry," March 7, pg. 4, col. 2.

_____ (1892b) "Gulf Fisheries--Interesting Results of the Investigation by the U.S. Fish Commission," December 12, pg. 7, col. 6.

_____ (1892c) "Louisiana Fisheries --Characteristics of the Industrial Statistics--Apparatus Employed and Value of the Products, The Cannery Trade," December 15, pg. 3, col. 5.

_____ (1892d) "Oysters," December 19, pg. 4, col. 2.

_____ (1902a) "The Great Oyster Interests of Louisiana," March 22, pg. 4, col. 1 and 2.

_____ (1902b) "This Draft of a Louisiana Oyster Law--A Legislature Commission Briefly Sketches the Provisions to be Included," April 7, pg. 10, col. 3 and 4.

The Daily States (1889) "New Orleans Oysters--Quality of the Crop This Year Better than Last," February 14, pg. 2, col. 1.

Day, Jr., J. W., W. G. Smith, P. R. Wagner, W. C. Stone (1973) Community Structure and Carbon Budget of a Salt Marsh and Shallow Bay Estuarine System in Louisiana, Center for Wetland Resources, L.S.U. Pub. No. LSU-SG-72-04, Baton Rouge, La.

Day, Jr., J. W., T. Butler, W. Conner (1977) "Productivity and Nutrient Export Studies in a Cypress Swamp and Lake System in Louisiana," Estuarine Processes, Vol. 2, pp. 255-269.

De Broca, P. (1876) "On the Oyster Industries of the United States," Report U.S. Fish Commission, 1873-1874, Vol. 3, U.S. Gov't Printing Off., Washington, D.C., pp. 271-320.

De Bon, M. (1875) "Report on the Condition of Oyster Culture in 1875, Preceded by a Report to the Minister of Marine and of the Colonies," Report of the Commissioner for 1873-1874 and 1874-1875, Part III, U.S. Commission of Fish and Fisheries, U.S. Gov't Printing Off., Washington, D.C., pp. 885-906.

Dean, B. (1893) "Report on European Methods of Oyster Culture," Bulletin of the United States Fish Commission, Vol. 11, pp. 357-406.

Dennett, D. (1883) "The Oyster Fields of Southern Louisiana," Daily Picayune, October 28, pg. 8, col. 3.

Dyer, J. O. (1917) "The Lake Charles Atakapas, Period 1817-1820," Howard

Memorial Library, New Orleans, Louisiana.

Dymond, Jr., J. (1904) "The Oyster in Louisiana," First Annual Report Oyster Commission of Louisiana, 1902-1904, pp. 83-107.

Ellis, M. M., B. A. Westfall, M. D. Ellis (1946) Determination of Water Quality, U.S. Fish and Wildlife Service, Res. Rept. 9, 122 pp.

Emmer, R. E. and J. Day (1977) "Sedimentary Environments, Ecological Systems, and Land Use in Southeastern Louisiana," in Petroleum Exploration School Field Trip Guide, Assoc. Amer. Petrol. Geol., New Orleans, La., pp. 1-44.

Fairman, Miller (1977) Personal Communication, Louisiana Wild Life and Fisheries Commission, New Orleans, Louisiana.

The Field (1869) "The Oyster Trade in the United States," May, Vol. 33, London, England, p. 388.

Forbes, E. and S. Hanley (1849) "On the Geographical Distribution and Uses of the Common Oyster, Ostrea edules," Edinburgh New Philosophical Journal of Natural Science, Vol. 47, No. 94, Edinburgh, Scotland, pg. 239-248.

Ford, T. B. (1968) "Oysters, Water Bottoms and Seafoods 1948-1968," Louisiana Conservationist, Sept.-Oct., pp. 46-48.

_____ (1979) Personal Communication, L. S. U., Baton Rouge, La.

Fortier, A. (1914) Louisiana--Comprising Sketches of Parishes, Towns, Events, Institutions and Persons, Arranged in Cyclopedic Form, Vols. I, II, III, Century Historical Association, pp. 285-289.

Found, H. R. (1957) "The Atlantic Oyster Industry," Trade News, Vol. 10, No. 6, pp. 3-7.

Frazier, D. E. and A. Osanik (1968) "Recent Peat Deposits Louisiana Coastal Plain" in Environments of Coal Deposition, (E. C. Dapples and M. E. Hopkins, eds.) Geological Society of America, Special Paper 114, ppg. 63-83.

Friedrichs, JR., A. V. (1962) "Oysters Through the Ages," Louisiana Conservationist, Vol. 14, pp. 11-12.

Fullarton, J. H. (1891) "The Oyster Fishery of Scotland," Proceedings Philosophical Society, Glasgow, Scotland, Vol. 22, pp. 110-127.

Gagliano, S. M. and J. L. Van Beek (1970) Geologic and Geomorphic Aspects of Deltaic Processes Mississippi Delta System, Hydrologic and Geologic Studies of Coastal Louisiana, Rept. No. 1. Center for Wetland Resources, L.S.U., Baton Rouge, La., 140 pp.

_____ (1975) "An Approach to Multiuse Management in the Mississippi Delta System" in Deltas As Models for Subsurface Exploration,

(M. L. Broussard, ed.), Houston Geological Society, pp. 223-238.

Galtsoff, P. S. (1931) "The Effect of Sulphite Waste Liquor on the Rate of Feeding of Ostrea lurida and Ostrea gigas, in Effects of Pulp Milll Pollution on Oysters (A. E. Hopkins, P. S. Galtsoff, H. C. McMillin, eds.), U.S. Bureau of Fisheries Bulletin, No. 6, Vol. 47, pp. 162-167.

_____ (1951) "The Oyster Industry of the World," in Marine Products of Commerce, (D. K. Tressler and J. M. Lemon, eds.), 2nd ed., Reinhold Pub. Corp., New York, N. Y., pp. 550-575.

_____ (1958) "The Oyster," Encyclopedia Britannica, Vol. 16, pp. 1001-1004.

_____ (1964) The American Oyster, "Crassostrea virginica" Gmelin, U.S. Department of Interior, Fish and Wildlife Service, Fisheries Bulletin, Vol. 64.

Gates, W. H. (1910) "A Few Notes on Oyster Culture in Louisiana, Gulf Biologic Station Bulletin 15, pp. 5-32.

Goode, G. B. (1884) "The Oyster Industry of the World," Bulletin U.S. Fish Commission 1884, Vol. 4, Washington, D.C., pp. 468-469.

Gould, H. R. and J. P. Morgan (1962) "Coastal Louisiana Swamps and Marshlands," Field Trip No. 9, Geology of the Gulf Coast and Central Texas and Guidebook of Excursions, Houston Geological Society, 1962, Meeting of the Geological Society of America and Associated Societies, Houston, Texas.

Grave, C. (1905) "Investigations for the Promotion of the Oyster Industry Of North Carolina," Report of the Commissioner, Part 29, U.S. Commission of Fish and Fisheries, Washington, D.C., pp. 249-293.

Gunter, G. (1949) "A Summary of Production Statistics and Facts Related to Development of the Oyster Industry of Louisiana with a Brief Comparison with other Gulf States," Texas A and M Research Foundation Pub. 2, pp. 1-28.

_____ (1949) "Gametogenesis in the Oyster Under Conditions of Depressed Salinity," Biology Bulletin, Vol. 96, No. 3, pp. 263-269.

_____ (1967) "Some Relationships of Estuaries to the Fisheries of the Gulf of Mexico," in Estuaries, American Association of Science, pp. 621-638.

Gutsell, J. S. (1923) The World's Oyster Industry, The Chemical Catalogue Company, Inc., New York, N. Y.

Hedgpeth, J. W. (1954) "Bottom Communities of the Gulf of Mexico," in Gulf of Mexico Its Origin, Waters, and Marine Life, Fishery Bulletin of the Fish and Wildlife Service, Bulletin 89, Vol. 55, U.S. Gov't Printing Off., Washington, D.C., pp. 203-214.

Hoek, P. P. C. (1880) "Oyster Cultivation in the Netherlands," U.S. Commission of Fish and Fisheries, Commissioners Report 1880--Propagation of Food Fisheries, U.S. Gov't Printing Off., Washington, D.C., pp. 1029-1035.

Hofstetter, R. P. (1967) The Texas Oyster Fishery, Bulletin 40, Texas Parks and Wildlife Department, Austin, Tx, 38 pp.

Hopkins, A. E., P. S. Galtsoff, H. C. McMillin (1931) "Effects of Pulp Mill Pollution on Oysters," U.S. Bureau of Fisheries, Bulletin 6, Vol. 47, pp. 125-186.

Huber, L. V. (1971) New Orleans--A Pictorial History, Crown Pub., Inc., New York, N. Y.

Ingersoll, E. (1890) "The Oyster, Scallop, Clam, Mussel, and Abalone Industries; Part XX-1: The Oyster Industry," Senate Miscelaneous Doc. 1881-1882, Vol. 10, U.S. Gov't Printing Off., Washington, D.C., pp. 507-565.

Jørgensen, C. B. (1952) "On the Relation Between Water Transport and Food Requirements of Some Marine Filter Feeding Invertebrates," Biology Bulletin, Vol. 3, No. 105, pp. 477-489.

Joyce, Edwin A. (1972) A Partial Bibliography of Oysters With Annotations, Special Science Report No. 34, Florida Department of Natural Resources, 846 pp.

Kellogg, J. L. (1910) Shell-Fish Industries, Holt and Co., New York, N. Y., 361 pp.

Kniffen, F. B. (1962) "Louisiana House Types," in Readings in Cultural Geography, (P. L. Wagner and M. W. Mikesell, Eds.), The University of Chicago Press, Chicago, Ill., pg. 163.

Kolb, C. R. and J. R. Van Lopik (1965) "Depositional Environments of the Mississippi River Deltaic Plain--Southeastern Louisiana," 15th Annual Gulf Coast Association of Geological Society Meeting, Houston, Texas, pp. 17-61, reprint.

Korringa, P. (1952)"Recent Advances in Oyster Biology," Quarterly Review of Biology, Vol. 27, pp. 266-308.

_____ (1953) "Oysters," Scientific American, pp. 86-92.

_____ (1956) "Oyster Culture and Biological Productivity, Rapp. Cons. Explor. Mer., Vol 140, No. 3, pp. 30.

Kwon, H. J. (1969) Barrier Islands of the Northern Gulf of Mexico Coast: Sediment Source and Development, Coastal Studies Institute, Tech. Rept. 75, L.S.U., Baton Rouge, La.

Lay, John (1977) Letter Concerning Oyster Leasing in Atchafalaya Bay, Louisiana Wild Life and Fisheries Commission, New Orleans, La.

Lee, C. F., C. H. Kurtzman, L. Pepper (1960) "Proximate Composition of Southern Oysters--Factors Affecting Variability," Commercial Fisheries Review, Vol. 22, No. 7, pp. 1-8.

Lee, C. F. and F. B. Sanford (1963) "Oyster Industry of Chesapeake Bay, South Atlantic and Gulf of Mexico," Commercial Fisheries Review, Vol. 25, No. 3, pp. 8-17.

Leipper, D. F. (1954) "Physical Oceanography of the Gulf of Mexico" in Gulf of Mexico Its Origin, Waters, and Marine Life, Fishery Bulletin of the Fish and Wildlife Service, Bulletin 89, Vol. 55, U.S. Gov't Printing Off., Washington, D.C., pp. 119-138.

Lobb, H. (1867) Successful Oyster Culture, Ridgway Pub., London, England.

Lobrano, Alan (1977) Personal Communication, Clerk of Court, Plaquemines Parish, Louisiana.

Lockwood, Samuel (1874) "The Natural History of the Oyster," Popular Science Monthly, No. 31, No. 32, pp. 1-20; 157-173.

Lopant, M. (1954) "The American Oyster Industry," World Fishing, Vol. 3, No. 6, pp 217-219.

Louisiana Gazette (1805) Letter to the Editor regarding Noisy Oyster Peddlers in New Orleans, May 4, pg. 3, col. 2.

_____ (1814) Wanted on Lease--Oyster House in New Orleans, Sept. 13, pg. 3, col. 4.

Louisiana State Department of Health (1972) Louisiana Oyster Water Survey; West Delta Marsh Areas III-A and III-B, Baton Rouge, La.

Louisiana State Museum (date unknown) Scrap Book 74A, "Oyster War--Trouble Expected in the Vicinity of Bayou Cook--Austrian Fishermen Object to People Whom They Term Trepassers Taking the Beds They Have Planted," New Orleans, Louisiana, pg. 31.

Louisiana Department of Conservation (1902) Oyster Plat Records, New Orleans, Louisiana.

Lovrich, F. M. (1960) "The Dalmatians in Louisiana," Louisiana History, pp. 149-164.

Mackin, J. C. and S. H. Hopkins (1961) "Studies on Oyster Mortality in Relation to Natural Environments and to Oil Fields in Louisiana," Publications of the Institute of Marine Science, Vol. 7, University of Texas, Port Aransas, Tx., pp. 3-131.

Mackin, J. G. and D. A Wray (1959) A Study of Mortality and Mortality Producing Agencies in Barataria Bay, Louisiana, Texas A and M Research Foundation, Project 9.

Matthiessen, G. C. (1970) A Review of Oyster Culture and the Oyster Industry

in North America, Woods Hole Oceanographic Institution, Mass., 52 pp.

Matthiessen, G. C. and R. C. Toner (1966) Possible Methods of Improving the Shell Fish Industry of Martha's Vineyard, Duke's County, Massachusetts, Marine Research Foundation Inc., Edgartown, Mass., 138 pp.

May,,E. B. (1971) The Oyster Industry of Alabama, Alabama Marine Resources Bulletin 4, Alabama Marine Resources Laboratory, Dauphin Island, Ala.

McConnell, J. N. (1956)"Division of Oysters and Water Bottoms," Sixth Biennial Report, Louisiana Wild Life and Fisheries Commission, New Orleans, Louisiana, pp. 134-157.

McConnell, J. M. and L. D. Kavanagh (1941) The Louisiana Oyster, Louisiana Department of Conservation Bulletin 1, New Orleans, La. 47 pp.

McGinnis, J. T., R. A. Ewing, C. A. Willingham, S. E. Rogers, D. H. Douglass, D. L. Morrison (1972) Environmental Aspects of Gas Pipeline Operations in the Louisiana Coastal Marshes, Final Report, Battelle, Columbus Laboratories, Columbus, Ohio.

McHugh, J. L. and R. S. Bailey (1957) "History of Virginia's Commercial Fisheries," Virginia Journal of Science, pp. 42-64.

McIntire, W. G. (1958) Prehistoric Indian Settlements of the Changing Mississippi River Delta, L.S.U. Press, Baton Rouge, La., 127 pp.

Medcof, J. C. (1961) Oyster Farming in the Maritimes, Fisheries Research Board of Canada, Bulletin 131, pp. 1-58.

Menzel, R. W. (1962)"Shell Fish Mariculture," Proceedings Gulf Caribbean Fisheries Institute, Vol. 14, pp. 195-199

Millar, R. H. (1961) Scottish Oyster Investigations 1946-1958, Marine Research Service, Scottish Home Department, Vol. 3, 75 pp.

Mississippi River Commission (1895) Maps of the Mississippi River, Sheets 30 and 31.

Mobius, K. (1880) "The Oyster and Oyster Culture," Commissioner's Report 1880, U.S. Commission of Fish and Fisheries, U.S. Gov't Printing Off., Washington, pp. 683-822.

Moore, H. F. (1897) "Some Factors in the Oyster Problem," House Documents Vol. 71, No. 561, Fish Commission Bulletin, Vol. 17, U.S. Gov't Printing Off., Washington, D.C., pp. 275-284.

_____ (1898) "Report on the Oyster Beds of Louisiana," Commissioner's Report 1898, U.S. Commission of Fish and Fisheries, U.S. Gov't Printing Off., Washington, D.C., pp. 45-100.

Moore, H. F. and T. E. B. Pope (1910) "Oyster Culture Experiments and

Investigations in Louisiana," Bureau of Fisheries Doc. No. 731, U.S. Department of Commerce and Labor, U.S. Gov't Printing Off., Washington, D.C., pp. 1-52.

Morgan, D. F. (1975) The Mississippi River, Legal-Geomorphologic Evaluation of Historic Shoreline Changes, L.S.U. School of Geoscience, Baton Rouge, La.

Morgan, J. P. (1972) "Impact of Subsidence and Erosion on Louisiana Coastal Marshes and Estuaries," Proceedings, Coastal Marsh and Estuary Management Symposium, L.S.U. Division of Continuing Education, L.S.U., Baton Rouge, La., pp. 235-259.

_____ (1974) "Recent and Geological History of the Timbalier Bay Area and Adjacent Continental Shelf," Melanges, No. 9, L.S.U. Museum of Geoscience, Baton Rouge, La., 17 pp.

Morgan, J. P. and P. B. Larimore (1957) "Changes in the Louisiana Shoreline," Transactions, Gulf Coast Association, Geological Society, No. 7 PP. 303-310.

Needler, A. B. (1941) Oyster Farming in Eastern Canada, Fisheries Research Board of Canada, Bulletin 60, 83 pp.

Orcutt, H. C. (1958) "California Oyster Ground Utilization Plan," Proceedings, National Shellfisheries Association, Vol. 49, pp. 98-100.

Owen, H. M. (1955) The Oyster Industry of Louisiana, Louisiana Wild Life and Fisheries Commission, Division of Oysters, Water Bottoms, and Seafoods, New Orleans, La., unpub. manuscript, 387 pp.

Padgett, H. R. (1960) The Marine Shell Fisheries of Louisiana, L.S.U. Baton Rouge, La., thesis, 378 pp.

Pattison, W. (1964) "The Four Traditions of Geography," Journal of Geography, Vol. 63, No. 5.

Payne, F. T. (1914) "Chief Surveyor's Report," Report of the Conservation Commission, 1912-1914, New Orleans, La., pp. 111-125.

_____ (1918) "Chief Surveyor's Report," Report of the Conservation Commission of Louisiana, 1916-1918, New Orleans, La., pp. 163-169.

_____ (1920) "Report of the Division of Water Bottoms," Fourth Bienniel Report, 1918-1920, New Orleans, La., pp. 131-153.

Pausina, B. V. (1970) "Louisiana Oyster Culture," Proceedings of the First Annual Workshop, World Mariculture Society, Baton,Rouge, La., pp. 29-35.

Pennell, Joseph (1882) "Barataria Luggers at the Fruit Landing," in The Creoles of Louisiana by G. W. Cable (1885), John C. Nimmo, Pub., London, England.

_____ (early 1880s) "Vessels Unloading at the Old Basin Canal Landing," in The Creoles of Louisiana by G. W. Cable (1885), John C. Nimmo, Pub., London, England.

Perret, W. S., B. B. Barrett, W. R. Latapie, J. F. Pollard, W. R. Mock, B. G. Adkins, W. J. Gaidry, C. J. White (1971) Cooperative Gulf of Mexico Estuarine Inventory and Study, Louisiana, Phase I: Area Description and Phase IV: Biology, Louisiana Wild Life and Fisheries Commission, Division of Oysters, Water Bottoms and Seafoods, New Orleans, La., 175 pp.

Peyrer, C. (1874) "Fisheries and Fishery Laws in Austria and of the World in General," Report of the Commissioner for 1873-1874 and 1874-1875, Part III, U.S. Commission of Fish and Fisheries, U.S. Gov't Printing Off., Washington, D.C., pp. 571-679.

The Plaquemines Protector (1887) Notices of Requests for Leases for Oyster Easting Establishments, Plaquemines Parish, Louisiana., Jan. 8.

_____ (1887) Notices of Requests for Leases for Oyster Eating Establishments, Plaquemines Parish, Louisiana, Jan. 15.

Quayle, A. H. (1956) Pacific Oyster Culture in British Columbia, Department of Fisheries, Victoria, British Columbia, 33 pp.

Radcliffe, L. (1950) "Potentialities of the Gulf Oyster Industry," Proceedings, Gulf and Caribbean Fisheries Institute, Vol. 2, pp. 14-15.

Riley, G. A. (1941) "Plankton Studies III Long Island Sound," Bulletin of the Bingham Oceanographic Collection, Peabody Museum of Natural History, Yale University, Vol. 7, pp. 1-93.

Riley, G. A. and S. Gorgy (1948) "Quantitative Studies of Summer Plankton Populations of the Western North Atlantic," Journal of Marine Research, Vol. 7, No. 2, pp. 100-121.

Russell, R. J., H. V. Howe, J. H. McGuirt, C. F. Dohm, W. Hadley, Jr., F. B. Kniffen, C. A. Brown, (1936) Lower Mississippi River Delta Reports on the Geology of Plaquemines and St. Bernard Parishes, Geology Bulletin 8, Department of Conservation, Louisiana Geological Survey, New Orleans, La., pp. 3-199.

St. Amant, L. S. (1958) "Oyster Culture in Louisiana, Our Need for a Continuing and Expanding Technical Program," Louisiana Conservation, December.

_____ (1964) Louisiana Leads in Oyster Production, Louisiana Wild Life and Fisheries Commission, Wildlife Education Bulletin 84, 11 pp.

Saucier, R. T. (1963) Recent Geomorphic History of the Pontchartrain Basin, Louisiana, U.S. Gulf Coastal Studies, Tech. Rept. No. 16, Part A, C.S.I., L.S.U., Baton Rouge, LA., 114 pp.

Schlesselman, G. W. (1955) "The Gulf Coast Oyster Industry of the United States," The Geographical Review, Vol. 45, No. 4, pp. 531-541.

Seferovich, G. H. "Marketing Louisiana Fresh Oysters, L.S.U., Baton Rouge, La., thesis,

The Sea World (1880) "Mine Oysters," Vol. 1, No. 26, New Haven, Feb. 9.

Shaw, W. N. (1965) "Pond Culture of Oysters--Past, Present and Future," Transactions North American Wildlife Conference, Vol. 30, pp. 14-20.

_____ (1970) "Oyster Farming in North America," Proceedings, First Annual Workshop, World Mariculture Society, L.S.U., Baton Rouge, La., pp. 39-45.

Shaw, S. P. and C. G. Fredine (1971) Wetlands of the United States, U.S. Department of Interior, Fish and Wildlife Service, Cir. 39, Washington, D.C., 67 pp.

Stafford, J. (1913) The Canadian Oyster--Its Development, Environment and Culture, Commission of Conservation, Canada, Toronto, Canada, 159 pp.

Steele, E. N. (1957) "The Rise and Decline of the Olympia Oyster, Olympia Oyster Growers Association, 126 pp.

Stevenson, C. H. (1894) "Bibliography of Publications in the English Language Relative to Oysters and the Oyster Industries," Report of the Commissioner for the Year Ending 1892, U.S. Fish Commission, Gov't Printing Office, Washington, D.C.

Talcott, A. (1839) Map of the Delta of the Mississippi River, Bureau of Topographical Engineers

Taylor, W. E. (1897) "Establishment of a Biological Station on the Gulf of Mexico," House Doc. Vol. 71, No. 561, Fish Commission Bulletin Vol, 17, U.S. Gov't Printing Off., Washington, D.C., pp. 185-188.

Treading, L. W. (1971) "The Louisiana Oyster," Louisiana Conservation, May-June.

Turner, R. E. and J. G. Gosselink (1975) "A Note on the Standing Crop of Spartina alterniflora" in Texas and Florida," Contributions to Marine Science, Vol. 19, pp. 113-118.

United States Census Records (1820, 1830, 1840, 1850, 1860, 1870, 1880) for Cameron, Iberia, Jefferson, Lafourceh, Plaquemines, St. Bernard, St. Mary, Terrebonne, and Vermilion Parishes, Louisiana, L.S.U. Library microfilm, Baton Rouge, La.

United States Coast and Geodetic Survey (1910) Mississippi River From the Passes to Grand Prairie, map, scale 1:80,000.

United States Commission of Fish and Fisheries (1887) The Fisheries and Fishery Industries of the United States, 1880, Section 2, Part XV,

_____ (1883)"Propagation of Food Fishes," Commissioners Report of 1880, Part VIII, U.S. Gov't Pringting Off. Washington, D.C.

_____ (1887) The Fisheries and Fisheries Industries of the United States, Vol. 2, U.S. Gov't Printing Off., Washington, D.C., Plates 237 and 238.

United States Department of Health, Education,and Welfare (1965) Sanitation of Shellfish Growing Areas, Public Health Service, National Shellfish Program I.

United States Department of Interior, Geological Survey (1922), Map of the state of Louisiana, scale: 1:500,000.

_____ (various dates) Topographic maps of coastal Louisiana, scales: 1:24,000 and 1:62,500.

Van Sickle, V. R., B. B. Barrett, L. J. Golick, T. B. Ford (1976) Barataria Basin Salinity Changes and Oyster Distribution, Wild Life and Fisheries Tech. Bull. 20, Sea Grant Pub. No. L.S.U.-T-76-002, L.S.U., Baton Rouge, La., 22 pp.

Vujnovich, M. M. (1974) Yugoslavs in Louisiana, Pelican Press, Gretna, La., 246 pp.

_____ (1977) "Experiences of a Croatian Oysterman in Louisiana," (as told by Marko Cibilic) Matica Croatian Emigrants Association Am Almanac for 1977, Zagreb, Yugoslavia, pp. 129-136.

Waldo, E. (1957) "The Louisiana Oyster Story," Lousiana Conservationist, Nov., New Orleans, La., pp. 1-11.

Welder, F. A. (1959) Processes of Deltaic Sedimentation in the Lower Mississippi River, Coastal Studies Institute, L.S.U., Baton Rouge, La., 90 pp.

Younge, C. M. (1960) Oysters, Willmer Brothers and Haran Ltd., Britenhead, London, England, 209 pp.

Zacharie, F. C. (1897) "The Louisiana Oyster Industry," House Documents, Vol. 71, No. 561, Fish Commission Bulletin, Vol. 17, U.S. Gov't Printing Off., Washington, D.C., pp. 297-304.

_____ (1898) "The Louisiana Oyster Industry," Daily Picayune, Feb. 17, p. 11, col. 5.

## APPENDIX 1

## GLOSSARY

Bank Barrel: A unit of measurement used in purchasing oysters from oystermen at the reefs or bedding grounds during the late 19th and early 20th century. One bank barrel equals 3 present day sacks or one and one half market barrels.

Bedding Grounds: Suitable water bottom (firm substrate, sufficiently moving currents, little sedimentation, medium to high salinity, adequate food, etc.) where oysters are deposited either for temporary holding or for improving their quality (flavor, fatness, etc.).

Bloating: Interchange of fluids between the oyster and the surrounding water whereby the oyster increases in size and appears fat. It occurs when oysters are transferred from salty environments to fresher waters. This process can occur when the oyster is living or immediately after it has been shucked.

Buy Boat: A boat sent to the tonging grounds or selected locations to purchase oysters from the men who have gathered them.

Commensalism: A situation whereby other organisms live in close proximity with oysters, sharing and at times competing with them for food gathered by the host.

Commercially Extinct: The point at which the living oysters on a water bottom become so few in number that it is not profitable to expend the necessary time and effort to harvest them for market.

Conch: Known variously as the oyster drill or snail. The species most common in Louisiana is Thais haemostoma haysae Clench. In earlier literature, it is often referred to as Purpura floridana. It is a large, rugged snail measuring up to 4.5 inches in height which feeds primarily on oysters and other molluscs. It is restricted to saline waters over 10 ppt.

Coon Oyster (also called raccoon and snapper): A long, narrow, usually low quality (thin and watery) oyster often found on intertidal mudflats. Their shape resembles a raccoon's paw and this may account for their name. Another explanation for this term is that raccoons frequently feed on them during low water.

Cordelling: Refers to the practice of hauling luggers by horse or man power up the Mississippi River during the period when sails were the primary source of power.

Counter-stock Oysters: The highest grade of oyster grown in Louisiana under the most carefully cultivated conditions. It is served, usually raw, on the half-shell at oyster counters, saloons or restaurants.

Cull: To separate oysters from one another and from shells or other debris in order to free the oyster to grow into a larger, more desirable shape

or to be sacked for market.

Cultch: Any kind of material placed in estuarine environments to attract the spawn of oysters. The material can be of any kind but it must have a clean, unfouled surface in order for oysters to successfully cement themselves to the surface. The term was originally employed in Europe, primarily France, to describe the oyster spawn (Ingersoll, 1889).

Cultivation: "A method by means of which the number of oysters are increased by artificial means above that produced under natural conditions" (Kellogg, 1910). Gates (1910) described cultivation as the process whereby oyster clusters were separated and redeposited singulaly for further growth.

Dense Oyster Bottoms: An oyster reef classification used by Moore (1898). These reefs have a large concentration of living oysters within a small area of water bottom.

Dredge: A metal or iron frame supporting a net bag which is dragged along the bottom of a sufficiently deep water body for the purpose of scooping up shellfish, especially oysters.

Drill: See conch.

Dynamic Equilibrium: A term frequently applied to the coastal deltaic plain of Louisiana signifying that the erosional processes are being offset by the progradational and aggradational processes of the Mississippi River Delta under natural, not man-altered, conditions (Morgan, 1972).

Fattening: a) See bloating.
b) An actual increase in an oyster's mass (weight) which is achieved over an extended period of time by placing an oyster in a suitable estuarine environment having sufficient food, water currents, and an absence of pollution, disease, and competition or commensalism.

Freshet: The flushing out or flooding of a water body by fresh-water during a heavy, prolonged rainfall or the annual overbank flooding of a stream or river.

Louisiana Marsh: "The great marshland of eastern St. Bernard Parish," (Russell, 1936). The marshlands of St. Bernard parish which "...extend from the Mississippi boundary line on the north to Plaquemines parish on the south, and from the Chandeleur Sound on the east to the zone where the water becomes too fresh to support oyster life" (Payne, 1920).

Lugger: A small sailing vessel supporting one or more lugsails which are four cornered sails, attached to an upper yard and hung obliquely from a mast. The name is also applied to a slightly modified version of sailing craft having lateen-rigged sails which are triangular sails attached to a long yard and suspended from a short mast. The latter is the typical sail characteristic of the Mediterranean while lugsails are more commonly associated with English fishing boats (Anderson and

Anderson, 1963).

Market Barrel: A unit of measurement used for selling oysters at the market place in the late 19th and early 20th century. It equals two thirds of a bank barrel.

Nippers: Modified tongs having long handles but small tong heads capable of picking up one or two oysters at a time from clear, relatively shallow water. They are much lighter in weight than regular tongs.

Plant: The process of scattering young, small sized oysters in thin layers over a firm bottom that is naturally suitable for oyster growth or that has been prepared artificially for the purpose of cultivation.

Plumping: See bloating.

Pollution: Any substance added to another (such as a water body) that lowers its quality thereby making it less suitable to serve its former or most desirable natural function or purpose.

Productive: As used by Payne (1920) this refers to an oyster reef's ability to increase in size by producing more oysters than are destroyed by natural forces. When modified by "highly," he means that the reef is very prolific and produces many young oysters. When modified by "non" he means that the reef is not producing a sufficient supply of oysters on a regular basis to maintain its structure or increase in size.

Prolific: In reference to this report, the term means that the oysters produce an abundant amount of young oysters under conditions that are favorable to their survival.

Raw Shop Oysters: Large, fat, well-shaped oysters that either grow or have been artificially cultivated to be of sufficient quality for shucking by hand. They are usually bedded 12 to 18 months on private oyster grounds but unlike counter stock oysters, they do not undergo the additional cultivation step involving temporary placement in highly saline waters to improve their flavor.

Reef: "A natural oyster reef, bar, or bed is an area of not less than 500 square yards of the bottom of any body of water upon which oysters are found or have been found within a term of five years immediately preceding the time at which the question concerning said bottom are decided, in quantities which would warrant taking them for profit by means of tongs" (Moore, 1898).

"...in cross section, a low mound with a high center, or "hogback," which is occupied by loose dead shells with the live oysters on the sloping shoulders" (Hedgpeth, 1954).

Salt Water Mixing: The process whereby saltier Gulf coast waters move into interior water bodies through tidal or wind generated currents and mix with the fresher interior water bodies thereby creating a salinity intermediate between the two salinities prior to mixing.

Seed: Young or immature oysters of suitable size for planting. The size can vary from young spat a fraction of an inch to well grown oysters which are almost three inches long. The usual range in size is between one and two inches (Cary, 1907).

Set: a) The process whereby oyster larvae settle onto a surface and cement their shell to that surface.
b) The mass settling and cementation of large numbers of oyster larvae during a spawning season.

Slavonian: For the purpose of this report the name refers to those persons of Slavic heritage who came to Louisiana in the 19th and 20th centuries from what is now the northwestern coast of Yugoslavia bordering on the Adriatic Sea. Other names applied to this group of people are: Austrian, Dalmatian, Tacko, Packo, Dalmatian Croat, South Slav, and Yugoslav.

Snail: See conch.

Spat: A young oyster less than one inch long. An intermediate stage between the free-swimming veliger larval form and the immature oyster. The term usually refers to oysters that have just cemented themselves and assumed their sedentary position.

Steam Canned Oysters: Oysters that are gathered from an uncultivated, naturally occurring reef when they are about two years old. Due to their awkward shapes they are often opened via a steaming process rather than a shucking process and are usually canned.

Strike: a) The process whereby oyster larvae settle onto and cement themselves to a substrate. A synonym for set.
b) The successful attachment of numerous oyster larvae during a spawning season. These oysters often form the basis for the next season's oyster seed crop.

Tongs: A tool for gathering oysters from deep water. It consists of two long handles hinged together near one end about two feet from the bottom each having a rake with teeth curved inward to form a basket capable of picking up and holding objects such as oysters. The handles can range from six to thirty feet in length and are used to retrieve oysters from deep water.

Veliger Larva: The word comes from the Latin word "velum" meaning veil and "gerere" meaning to carry. It designates the larval stage of an oyster existing in the free-swimming stage.

Working (a bed): To break up the clusters of oysters in order to improve their growth rate and quality of shape, size and fatness. This is one step in the process of cultivating oysters on private grounds.

# APPENDIX 2

## LOUISIANA'S COMMERCIAL OYSTER "CRASSOSTREA VIRGINICA" GMELIN: ITS BIOLOGY AND ENVIRONMENTAL FACTORS INFLUENCING ITS GROWTH, REPRODUCTION AND DISTRIBUTION

The commercial oyster industry of Louisiana has developed around a single species. It is commonly known as the American or eastern oyster, but its scientific name is Crassostrea virginica Gmelin. Taxonomically, the oyster belongs to the sub-kingdom or phylum of animals labeled mollusca. Of the four or five classes of mollusks, oysters belong to the class bivalvia or Lamellibranchia (Stafford, 1913). It is classed as a bivalve because it has two valves or shells which are joined by a hinge at the narrower end (Churchill, 1920). Over 20 families are included in the class bivalvia, and the oyster belongs to one of these Ostreida. There are around 70 living species of ostrea and about 200 fossil species distinguished in the geologic record (Stafford, 1913).

The species dates from the Carboniferous era and reached its culmination in the Cretaceous (Stafford, 1913). Today oysters are distributed around the world in a broad belt of coastal waters between the latitudes 64° N and 44° S (Galtsoff, 1964). Generally, oysters thrive best in shallow waters extending from about halfway between the high and low tide marks to waters approximately 100 feet deep (Galtsoff, 1964). However, most commercial oyster beds are found at depths less than 40 feet (Galtsoff, 1964).

The greatest natural oyster producing areas of the world, as recognized in the early 20th century, included the shallow coastal waters located between the Gulf of St. Lawrence and the Gulf of Mexico, the Mediterranean, Adriatic and Black Seas, the Bay of Biscay, the English Channel and portions of the North Sea. Smaller producing areas were

located in Japan, China, India, Java, Australia, Tasmania, New Zealand, Brazil, California and British Columbia (Stafford, 1913). Changing environmental conditions, overfishing and improved cultural techniques, however, have since made such generalizations inaccurate, because formerly productive areas are now depleted and once marginal environments have become productive with technical developments by man.

## The Anatomy of an Oyster

An oyster is composed of two major parts, the external shell and the internal anatomy or animal. The shape of the external shell may vary greatly depending upon differing environmental factors. Largely because of the shell variation there was much confusion in early literature over the classification of oysters as different species. Often the oyster shell will faithfully reproduce the configuration and detailed structures of the object to which it is attached (Churchill, 1920). In some cases oysters growing on flat surfaces in calm water will have a round shape and poorly developed umboes. The same species will acquire a long, slender, laterally compressed body with hook-like umboes when growing on soft, muddy bottoms or overcrowded reefs. Oysters growing on a shell or pebble and slightly elevated above the substrate will have deep lower valves, more or less radially ribbed (Galtsoff, 1964).

An oyster's shell consists of two valves that are held together at the narrower anterior end by a dark-colored elastic hinge ligament (Fig. 28). A large muscle in the living oyster controls the movement of the shell; by relaxing, it opens the valves and by contracting tightly it closes them. When the oyster dies, or the muscle is cut, the valves open freely, exposing the internal oyster (Churchill, 1920).

An adult oyster shell can vary in thickness from one fourth inch

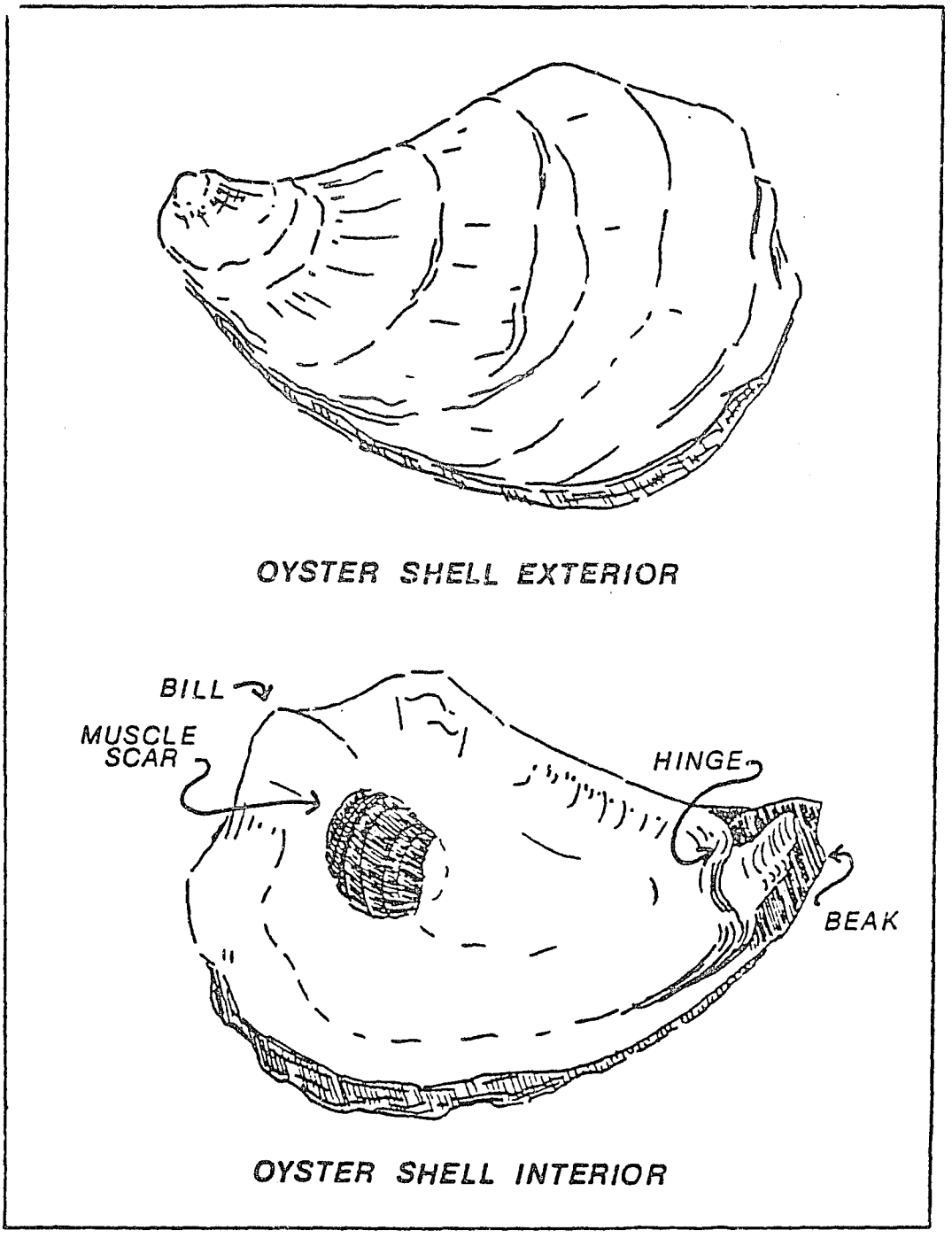



Fig. 28 Drawing of the exterior and interior portions of an oyster shell, Crassostrea virginica (Hofstetter, 1967).

(6.35 mm) to as much as one and one fourth inches (31.75 mm) but the normal range is from one fourth (6.35 mm) to three eights inches (317.50 mm). In an individual shell, the thickest portion of the shell if found near the anterior end and decreases to paper-thin thickness along the rapidly growing margins (Churchill, 1920).

The oyster valve consists of three layers: 1) the periostracum, 2) the prismatic, and 3) the ostracum. The periostracum, or outer layer consists of a very thin layer of horny material. The middle or prismatic layer is best developed on the flat or right valve of the oyster. This, along with the thickest inner or ostracum layer, is composed primarily of calcium carbonate (lime) (Hofstetter, 1967; Galtsoff, 1964). A fourth layer is under the place of attachment or the adductor muscle and consists of a very thin layer of aragonite (orthorhombic $CaCo_3$)(Galtsoff, 1964).

The following description of an oyster shell was presented by Moore in 1898:

> The exterior is marked by laminations and more or less concentric lines of growth; it is often covered by a yellowish cuticle, but is sometimes white and flinty in appearance. The inside of the shell is generally white, somewhat tinged with purple near the margins, and with a more or less pearly luster. The muscular impression is generally nearer to the posterior margin than to the hinge; it is a well-defined scar, kidney-shaped in specimens of ordinary size, but becoming more elongate in very large individuals; in young specimens it is pale, but it afterwards becomes purple or almost black. The left, or lower, valve is deeply concave within, the upper valve being flat or, usually, slightly concave. The animal portions are large, nearly filling the shell and the mantle border is comparatively narrow.

The internal structure of the oyster consists of 10 major parts: 1) mantle, 2) gills, 3) muscle, 4) anus, 5) heart, 6) liver, 7) stomach, 8) gonads, 9) palps, and 10) mouth (Fig. 29). The mantle is a soft membrane that covers the body of the oyster. The left and right sides

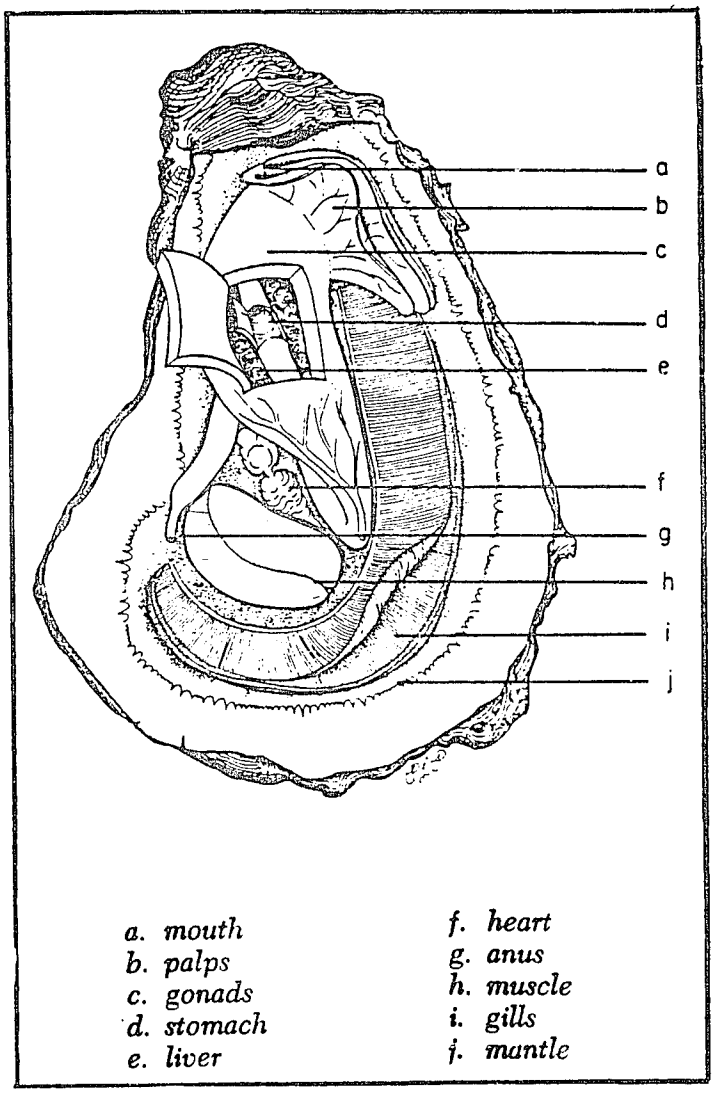



Fig. 29 Internal anatomy of an oyster, Crassostrea virginica (after Hofstetter, 1967).

of the mantle are joined at the dorsal edge and at the ventral margin but remain unconnected along the remaining mantle margins. The principal function of the mantle is to secrete material for construction of the shell layers and hinge ligament. Its additional functions include controlling the flow of water for respiration and feeding, aiding in the discharge of eggs from the oyster during spawning and receiving and transmitting sensory stimuli (Galtsoff, 1964).

The mantle cavity of a live oyster is filled with seawater, and even

when the shell is closed this water remains to bathe the enclosed organs. This water is transformed into shell liquor by the accumulation of products of oyster metabolism, mucus and blood cells. The retention of shell liquor in a tightly closed shell is an important adaptation for life in the inter-tidal zone, and also enables those in deeper water to survive temporary unfavorable conditions such as flooding by fresh water or toxic or irritating substances (Galtsoff, 1964).

The well developed adductor muscle controls the movement of the shell valves. On contracting it closes the shell and on relaxing it opens the shell permitting the oyster to feed, respire and eliminate wastes.

The heart is located above the adductor muscle in the pericardial cavity. The oyster possesses an "open" type of circulatory system. The colorless blood is pumped by the heart not through arteries and capillaries back into the veins as in higher organisms, but into large spaces or lacunae between the tissues. After it bathes the cells, it is collected by veins and returned via the gills to the lower chamber of the heart (Churchill, 1920).

The gills have been described as "long, curved, fringe-like organs lying between the mantle flaps" (Hofstetter, 1967). Each gill is covered by rows of very fine hairs called cilia. When the oyster valves are open the constant back and forth motion of the cilia create currents of water to pass over the gills, and deliver oxygen and food and remove wastes. The deliverance of food to an oyster is well described by Brooks (1880):

> The food of the oyster consists entirely of minute animal and vegetable organisms and small particles of organized matter. Ordinary sea water contains an abundance of this sort of food, which is drawn into the gills with the water, but as the water strains through the pores into the water tube, the food particles are caught on the surface of the gills by a layer of adhesive slime which covers all the soft parts of the

> body. As soon as they are entangled the cilia strike against them along the gills toward the mouth. When they reach the anterior ends of the gills they are pushed off and fall between the lips (labial palps in Fig. 29) and these again are covered with cilia, which is always wide open and ciliated, so as to draw the food through the oesophagus into the stomach. Whenever the shell is open these cilia are in action, and as long as the oyster is breathing a current of food is sliding into its mouth.

The food thus passes by movement of cilia from the gills to the labial palps to the mouth, located between the palps and the hinge of the shell, and then into the stomach via a short gullet. After being acted upon by fluids from the liver, food in the stomach is moved into the intestine which "extends from the stomach toward the muscle and gills, circles back around the stomach and ends in an anus near the muscle" (Hofstetter, 1967). The nutritive portion of the food is absorbed and the unused portion or feces are discarded via the anus and transported away from the shell by water currents agitated by cilia on the gills. The liver or digestive glans is that mass of dark colored tissue that surronds the stomach.

The reproductive organs or gonads of an oyster have the same general appearance, position and form in both the male and female of the species. This reproductive organ "consists of a mass made up of microscopic tubules and connective tissue lying between the folds of the intestine and investing it and the stomach and liver in such a manner as to cover the visceral organs when the open oyster is viewed from either side" (Churchill, 1920). Sperm from the male and eggs from the female pass from the gonads via ducts into the mantle cavity near the gills and are then expelled via currents into the surrounding waters.

The oyster has a very rudimentary nervous system, but no brain.

The adductor muscle is controlled by a pair of ganglia (knot of nervous matter) located beneath the muscle and connected by nerves to two ganglia lying over the gullet. Smaller nerves radiate from the two pairs of ganglia to other parts of the oyster tissue.

## Oyster Reproduction and Early Development

The sex of an oyster can only be determined through microscopic examination of the gonads during reproductive periods. The spawning oyster is classified as a male if sperm is present and as a female if there are eggs. However, oysters are peculiar in that they may change their sex one or more times during their life time. The exact cause of their sex instability and factors influencing changes are not known. In rare circumstances, an oyster may be hermaphroditic, i.e. contain both functional spermatozoa and ova in the gonad. Studies by Burkenroad in 1931, indicated that about one percent of the oyster population in Louisiana was hermaphroditic. While there is conflicting testimony, Galtsoff's studies indicate that hermaphroditic oysters can produce normal larvae through self-fertilization (Hofstetter, 1967; Galtsoff, 1964).

However, fertilization of eggs occurs outside of the oyster in the water column after the eggs and sperm have been ejected from the shell (Fig. 30). The simultaneous release of these two products is attained through mutual stimulation of male and female oysters. Studies on the triggering mechanism indicate that oysters will spawn when the "critical condition" of the organism makes it responsive to stimulation (such as the presence of either eggs or sperm in the water column) and not just when a specific temperature is attained. Spawning can occur over a broad range of water temperatures (15° to 34°C or 59° to 94°F), but mass spawning is most common in water water above 22° to 23°C (72° to 74°F).

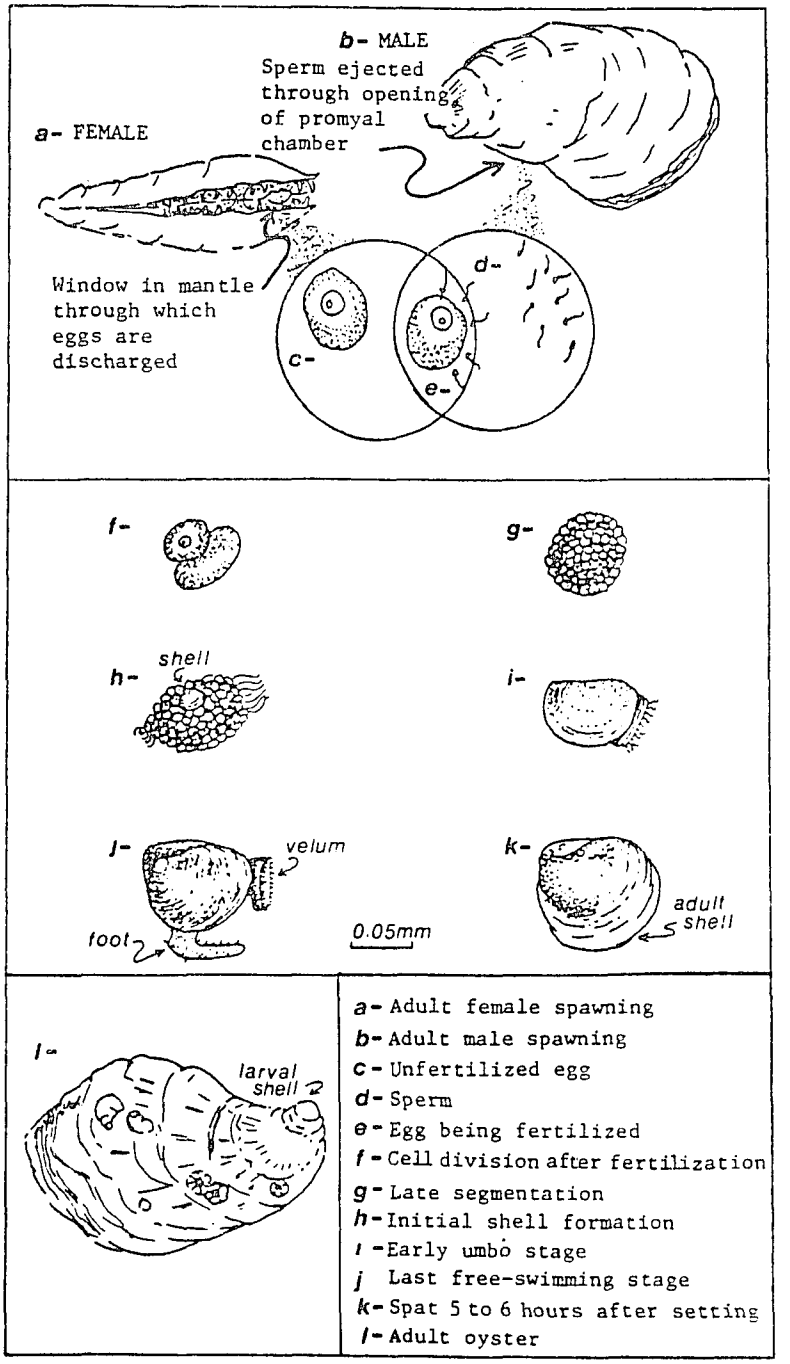



Fig. 30 Spawning and early development of an oyster, Crassostrea virginica (Galtsoff, 1964; Hofstetter, 1967).

A sudden rise in water temperature often acts as a stimulus to spawning in the late spring. During some years, decreasing temperatures in the early fall may have a similar effect on spawning. Thus, there may be two peak spawning periods or one may be major while the other is minor in terms of the success of the set. Such sets are influenced chiefly by environmental factors (Ford, 1979).

Studies indicate that males will spawn more readily than females and that they can be induced to spawn many times in a short period of time. Females, in contrast, spawn only a few times during a breeding season. The number of eggs or sperm released by an individual oyster depends upon the size of the oyster and the degree of development of the gonad. In a poorly developed female gonad, only a few thousand eggs will be released whereas, a large oyster with a well developed gonad will eject several million eggs (from 15 to over 100 million) (Galtsoff, 1964).

Initiation of spawning by one individual oyster (usually the male) results in almost simultaneous spawning of the entire community. This is an essential adaptation to the estuarine environment in that it guarantees a maximum number of eggs and sperm in the water column at the same time and enhances the chance for contact and fertilization. Tidal currents further enhance the opportunity for fertilization and development of oyster larvae by keeping the two products in suspension and increasing the period of possible contact (Galtsoff, 1964).

Once fertilized, the egg begins to divide and within several hours (five to ten hours) an oyster embryo is formed. Small hairs or cilia on the body's exterior enable the small larvae to swim to a limited extent. However, water currents are the major factor governing the distribution of larvae throughout a water body. Within a few days, the shell develops and

the oyster achieves the appearance of a tiny hard shell clam. From between the shell protrudes a disk or velum which is covered with cilia and provides the **veliger larva** (Appendix 1) with a stronger means of locomotion. The free-swimming period lasts from as much as 14 to 18 days in colder waters to as little as a week in warmer southern waters (Churchill, 1920; Hofstetter, 1967).

When the veliger larva is approximately one third of a millimeter long, it is ready to end its free-swimming stage and set. In this process, it settles onto a firm, clean surface such as a rock, shell, stake, piling, or even a can or discarded tire. While the veliger larva has the ability to test various surfaces for setting suitability, it must do so quickly at the end of its free-swimming stage for without a suitable surface it will die. Once a suitable surface had been located, the oyster attaches itself by cementing its left valve to the chosen surface. The swimming organ disappears and the oyster can no longer move under its own volition.

As the interior body of the oyster grows, the shell is enlarged by secretions from the mantle. The rate of growth varies considerably according to factors such as season of year, water temperature and salinity, food availability, and the presence of environmental stresses. The shape of the oyster's shell is governed by the environmental setting. Overcrowding, such as occurs on a reef, will result in very elongated, thin shelled oysters. Likewise, oysters settling on soft mud will sink into the mud as they increase in weight, and thereby elongate themselves so as to keep their bill above the mud surface and continue feeding. The shape that results from a particular type of substrate is a significant factor in marketing oysters. On firm water bottoms and in uncrowded conditions, the oyster shell will develop well-cupped valves. These con-

tain pleasantly shaped oyster meats which are esthetically pleasing to the counter trade clientele. The single, firm, well-shaped shell is easy to open or shuck, thereby making this a very desirable oyster on the market.

## Positive Environmental Parameters Affecting Oyster Distribution and Condition

Whereas the distribution of oysters is widespread throughout the coastal zone, certain environmental parameters have a significant bearing on the viability of the community and the quality of the oysters. Often these parameters are classified into categories according to what is most beneficial to oyster productivity. These parameters include those conditions that are positive and should be enhanced and those that are negative and should be curtailed (Galtsoff, 1964; Table 12).

Table 11
Environmental Parameters Affecting Oysters

| Positive Factors | Negative Factors |
|---|---|
| 1) Substrate | 1) Sedimentation |
| 2) Salinity | 2) Predation |
| 3) Water Temperature | 3) Competition and Commensalism |
| 4) Water Currents | 4) Disease |
| 5) Food Type and Availability | 5) Pollution |

### Substrate

The nature of the bottom on which an oyster sets is of utmost importance because it determines to a large extent its probability of survival. A veliger larva can only set or cement itself on a clean, unfouled surface, and once set it can not relocate. An ideal setting area consists of either a hard, rocky surface or a piece of cultch on semihard mud. Such surfaces will support the weight of the oyster as

as it grows. In contrast, a soft mud bottom permits the growing oyster to sink and be smothered. A sandy bottom is equally unsuited because shifting sand can smother oysters. Also, current tossed sand can be abrasive and injure the oysters' valves and impair their ability to protect themselves from other undesirable elements of the surrounding environment.

If all factors, except the nature of the substrate, are suitable for oyster growth, and cultivation is desired, the bottom can often be improved artificially. For example, a soft mud bottom may be hardened at relatively little expense by the addition of clam or oyster shells, if they can be acquired locally. Over a period of time, oysters can themselves improve the bottom by the gradual growth of the oyster community into a reef area which in turn serves as an elevated stratum for attachment of future generations of oysters.

Water Movement

The ideal situation for current movement is a steady, non-turbulent flow of water over the oysters. Because the oyster is sedentary, a constant stream of water is required to deliver food and oxygen and to remove wastes. Currents set up by cilia on the oyster's mantle are only sufficient to deliver food from a distance of about two inches (Galtsoff, 1964). A steady current also sweeps away sediment that would otherwise settle on the oysters, either smothering them, or fouling the shell structure thereby prohibiting attachment of spat. Currents are also essential to reproduction in that they increase the chance of contact of eggs and sperm and the resultant fertilization in the water column. Currents disperse the larvae over a wide area thereby increasing their chance of finding a suitable substrate on which to settle.

Type and Availability of Food

The diet of an oyster is composed of microscopic plants (phytoplankton) and animals (zooplankton), bacteria and organic detritus (Van Sickle, et al., 1976). Studies indicate that oysters require not more than 0.15 mg of utilizable organic matter per liter of water used (Jørgenson, 1952). Investigations of American coastal waters show that organic matter ranges from 0.17 to 2.8 mg per liter (Riley, 1941; Riley & Gorgy, 1948). Food sampling in Louisiana waters indicate that "at all times and at all stations sampled there were sufficient numbers and kinds of microorganisms present in the water to support existing populations of oysters" (Owen, 1955).

Oyster feeding can occur at all hours of the day and night and in summer months may be almost continuous over a 24 hour period (Hofstetter, 1967). Due to coastal Louisiana's extended warm season, feeding occurs longer here than in many other coastal areas of the United States. This extended feeding period enables oysters to grow larger faster. It should be noted, however, that the oyster is a discriminate eater and will starve even in the presence of high phytoplankton concentrations if they are of unsuitable size or type (Galtsoff, 1964).

Water Salinity

Oysters are classified as euryhaline organisms because they can tolerate a wide range of water salinities. Even exceedingly high or low salinities that are normally fatal can be survived for a limited period of time due to the oyster's ability to tightly close its shell and remain isolated from the unfavorable conditions. The range of salinities most favorable to oysters are the polyhaline zone (30 ppt to 18 ppt ) and the mesohaline zone (18 ppt to 5 ppt ) (Galtsoff, 1964).

Where average salinities are lower than 10 ppt, as in the upper reaches of some estuaries, oysters are often decimated by fresh water flooding. Oyster mortalities can be excessive if flooding is prolonged, especially during the warmer months of the year. In high salinity areas, oysters are commonly preyed upon by a variety of predators. Also, in low salinity areas the reproductive capability of oysters is inhibited primarily due to the failure of gonad development which may in turn be due to the impaired feeding ability sometimes associated with low salinities (Galtsoff, 1964).

Water Temperature

Oysters tolerate a wide range of water temperatures and are therefore termed poikilothermic organisms. In northern climates, they may be exposed to temperatures approaching 32°F (0°C) in winter, while in southern climates, they can experience water temperatures well over 90°F (32°C). Temperature is a major factor in the oyster's environment in that it influences many of the oyster's activities such as feeding, water transport, respiration, spawning and gonad development (Galtsoff, 1964).

However, the exact cause and effect relationship between temperature and oyster behavior is complicated by other factors in the environment such as salinity, and temperature alone may not be the controlling factor. For example, ciliary motion of the gills is at a maximum at temperatures between 77°F (25°C) and 79°F (26°C). During this time, water movement and food and oxygen intake can be maximized and oysters grow rapidly. Above 90°F (32°C) and below 70°F (21°C), ciliary activity declines and below 41°F (5°C) to 45°F (8°C) it ceases completely (Van Sickle, et al. 1976). While oysters do not spawn at a given temperature, a sudden

rise in temperature will trigger spawning of gonads that have ripened during the rise in water temperatures in late winter and early spring (Galtsoff, 1964).

It has also been found that in northern latitudes with a depressed range of temperatures, greater gonad development occurs as the reproductive season is shortened to four to six weeks in late spring and summer. In more southern latitudes, the reproductive season lasts for several months, and it was found that oysters were "kept near gonadal exhaustion for six to eight months of the year due to prolonged high temperature stimulation" (Van Sickle, et al., 1976).

However, establishing a direct cause and effect relationship due to temperature is often difficult because the effect may be due to other contributing factors such as salinity. For example, studies by Mackin and Wray (1959) and Owen (1955) indicated that "excessive mortalities in the Barataria Bay region (of Louisiana) occur when there is a combination of high temperature and high salinity (Van Sickle, et al., 1976).

### Negative Environmental Parameters Affecting Oyster Distribution and Condition

Other environmental factors that influence the distribution and well being of an oyster community include: sedimentation, competition, predation, pollution and disease. Galtsoff (1964) termed these environmental factors negative because they:

> ...decrease or inhibit reproductive capabilities, destroy the population by causing extreme adverse conditions; increase the incidence of disease; inhibit the fattening and growth of oyster body, thus decreasing the productiveness of an oyster bed; and interferewith the formation of shell and so deprive the oysters of their principal means of protection against adverse situations and attacks of enemies.

Sedimentation

The degree of sedimentation and associated water turbidity governs the severity of its impact on the oyster community. While an oyster has adapted to the normally turbid estuarine environment, too much sediment in the water column will inhibit feeding activity because the oysters are unable to filter excessive amounts of suspended particles. High turbidity can also decrease light penetration, thereby reducing the rate of phytoplankton production. This in turn can reduce the amount of food available to oysters. Even light siltation, as little as one or two millimeters thick, on the surface of shells and rocks, makes these surfaces unsuitable for attachment of the veliger larvae. This in turn leads to failure of setting and greatly decreases reproduction and the ability of a community to maintain itself. More rapid rates of siltation, such as one to three inches (25 to 76 mm), will smother adult oysters depending upon their size (Van Sickle, et al. 1976).

Pollution

There are many different types of pollution each of which will have a different effect upon oysters, depending upon the type, amount and duration. Two types that most frequently threaten coastal oyster grounds are domestic sewage and trade wastes (Galtsoff, 1964).

Introduction of domestic sewage into oyster producing areas can have three major effects. First, the sewage sludge can cover and smother the living oysters. Second, the sludge in the process of decaying, increases the BOD (biological oxygen demand) of affected waters. This reduces the amount of oxygen in the water and thereby impairs the normal functioning of oysters. Third, domestic sewage increases the bacterial content of the water. While these bacteria may not be lethal to oyster populations, the

bacteria are retained and accumulated in the bodies of these filter-feeding organisms. Some of these microorganisms are pathogenic and can cause potentially fatal diseases such as typhoid fever and hepatitis in humans who consume raw oysters. Some pathogens are resistant to heat and even cooking the oysters does not remove the danger of infection.

In areas of domestic sewage discharge, public health services using state and Federal regulations, monitor the coliform levels of water in oyster growing areas. When the abundance of coliform bacteria, in particular Escherichia coli, exceeds the permissible maximum of 70 per 100 ml, and over 10 percent of the samples exceed a MPN of 230 per 100 ml, the grounds are closed to oyster harvesting (US Dept. of Health, Education and Welfare, 1965).

However, oysters have the ability to flush these harmful bacterial organisms from their system within a short period of time. Therefore, provision is usually made in state regulations to allow authorized persons to remove the oysters from polluted to unpolluted grounds, where after a given period of time they may be safely marketed (Louisiana State Dept. of Health, 1972).

Industrial or trade wastes are often more destructive to oysters than are domestic wastes. Galtsoff (1964) listed wastes from the production of the following products to be major sources of industrial pollution: oil, paper, steel, chemicals, paints, plastics, leather and food processing or manufacturing plants. Some products are immediately lethal due to their toxicity. Other emissions retard the normal physiographic functions, thereby weakening the oysters and subjecting them to death from other causes such as disease, starvation or predation. In discussing the effect of pollution, Galtsoff (1964) states that "all

types of pollution are harmful to marine populations; only the degree of their effects differs."

Predation

The enormous array of animals that prey on oysters as a source of food include crustaceans, fishes, molluscs, echinoderms, flatworms, birds and mammals. The type of species present in a given area depends upon the geographic location and environmental factors such as temperature and salinity. The damage that they inflict upon an oyster community will depend upon the number and destructive capability of the predators and the degree of preference they have for oysters in contrast to alternate types of food.

Along the Gulf coast, in the vicinity of Louisiana, the most destructive predators, besides man, include the conch or oyster drill (Thais haemostoma haysae Clench), blue crabs (Callinectes sapidus Rathburn), stone crabs (Menippe mercenaria Say) and drum (Pogonias cromis). Of these four, the drill is probably the most universally destructive and capable of exerting a large influence on the location of artificially cultivated oyster beds. The drill common to Louisiana is a large, rugged snail which can reach a height of 4.5 inches. In earlier literature this drill was often referred to as a snail (Purpura floridana). It feeds primarily on oysters and other molluscs and seems to prefer small specimens less than 2 inches long, most likely because their shells are easier to drill through (Hofstetter, 1967; Moore, 1898).

Because of their great fecundity and the high survival rate of the larvae, this species multiplies rapidly in Gulf coastal waters. However, the drill is restricted to saline waters because a salinity as low as 10 ppt will immobilize it and exposures of 7 ppt for one to two weeks will

kill it (Galtsoff, 1964). Periodic flushing by fresh-water during the year appears to be the only effective means to date to control this predator which would otherwise wipe out a freshly planted seed ground or new sets on natural subtidal reefs.

Crabs can pose a serious threat to oysters especially freshly planted seed, which they crush with their claws prior to consuming the meat. However, they are not as destructive as the drill, since they have more eclectic food preferences. Furthermore, crabs, especially the blue crab, are an important seafood, therefore they are profitably trapped and their numbers controlled in oyster planting areas (Hofstetter, 1967).

There have been accounts of extensive damage caused to oyster grounds by black drum along the Gulf coast. These fish have powerful jaws and pharyngeal teeth capable of crushing oyster shells. Most reported damage involves newly planted oysters where there are numerous small, single oysters which are easy to crush. It is assumed that damage to natural reefs are probably negligible (Hofstetter, 1967; Moore, 1898).

Competition and Commensalism

In addition to predators that consume the oyster meat, a variety of other organisms threaten the oyster's existence by competing with it for space or food. For example, fouling organisms such as mussels (Brachidontes spp.), barnacles (Balanus spp.), encrusting forms of Bryozoans (Membranipora spp.), upright and branching forms of Bryozoans (Bugula spp.) and local or seasonal species such as sea-squirts, hydroids, algae, slipper shells and tube-building worms, like the oyster, require a place for attachment (Hofstetter, 1967; Galtsoff, 1964). If abundant, these other organisms may occupy and foul surfaces, thereby making them unsuitable for oyster setting.

A dense cover of fouling organisms over an oyster community may also diminish the oyster's food supply thereby resulting in a poor quality oyster.

Mussels are usually associated with low salinity waters and generally do not become a problem in more brackish environments. However, where present they are often a cause of poor quality oysters because of their competition with the oyster for food. Furthermore, their encrusting presence on the oyster's shell makes harvesting tedious and time consuming since the mussels must be removed from the oyster's shell before it can be marketed profitably.

A similar problem of overcrowding can also occur in areas of high oyster spat sets where the older shells are thickly colonized by young oysters. Large oysters whether encrusted by mussels or young spat are difficult to market because the shells must be cleaned or separated in order to facilitate shucking. Generally, such tightly clustered oysters are also small, poorly shaped and thin.

Several species use the oyster's shell for protection. While they do not eat the meat, their presence can weaken the oyster in a variety of ways. Three species, the boring clam, boring sponge and mudworm, have been called "termites" of the shell for like termites they weaken the structure (Hofstetter, 1967).

A boring clam (Diplothyra spp.) enters the shell by boring a single hole when young and enlarging the cavity as it grows. The boring sponge (Cliona spp.) in contrast creates an extensive network of tunnels with numerous openings throughout the shell. Both organisms cause the oyster to expend extra effort to secrete additional layers of shell in order to seal off the penetration and irritation of a growing clam or tunneling sponge.

Furthermore, shells riddled with numerous clam holes or sponge tunnels are brittle and easily broken when handled. This makes harvesting the oysters a risky procedure, for if broken prior to sale and shucking the meat may spoil. Both of these species prefer high salinity waters and their infestation can be controlled by periodic flushing by fresh water, such as occurs during overbank flooding or crevassing through natural or artificial levees in the coastal zone.

The mudworm does not burrow into the shell, but rather enters between the open valves, and once inside the shell, it constructs a shelter of mud. This irritates the oyster causing it to secrete a layer of shell or "mud blister" to cover the worm structure. In the case of all three organisms (boring clam, boring sponge and mudworm), the oyster must expend extra effort in shell construction to isolate itself from the intruders. This in turn can weaken the oyster, making it more susceptible to disease or predators. In general, oysters heavily infested by boring organisms are of poor quality and not highly marketable.

A fourth shell inhabitant is the oyster crab (Pinnotheres spp.) which seeks protection inside the shell. While it does not eat the meat, it eats some of the food being filtered by the oyster. Ordinarily, it is not considered a great threat and often the crab is eaten along with the oyster when it is consumed by humans. However, oyster mortalities have been associated with heavy crab infestations in some areas (Hofstetter, 1964).

Diseases

There are a number of diseases, both contagious and non-contagious, that either weaken or kill oysters. Non-contagious diseases are usually associated with the malfunctioning of physiological systems of organs or with poor environmental conditions such as insufficient food, unfavorable

salinity or water temperature, and pollution (Galtsoff, 1964).

Contagious diseases are traceable to pathogens and parasites. However, it is often difficult to attribute mortality to either of the above causes. Oysters weakened by a poor environment are more susceptible to pathogens, while pathogens present in apparently healthy oysters may prove fatal if they undergo stress due to worsening environmental conditions.

The most persistant pathogenic organism responsible for large numbers of mortalities in the Gulf coast waters is the fungus parasite (Dermocystidium marinum) which was recently reclassified as Labyrinthomyxa marina (Van Sickle, et al., 1976). The following information on the fungus and its affect on oysters in Louisiana was presented by Owen (1955):

1) Labyrinthomyxa marina is a causative agent of oyster disease, which is histolyic in nature,

2) The disease is lethal to oysters under conditions of high temperature,

3) High temperature and high salinity produce optimum conditions for the spread of the organism,

4) Oyster production in Louisiana is seriously affected by the disease,

5) Infected oysters in an optimum environment usually recover from the infection, based on degree of infection,

6) This fungus is probably the major cause of unusual widespread mortalities of Louisiana oysters,

7) The consumption of infected oysters by humans does not, under any circumstance, produce or have any detrimental effect.

Several other pathogenic organisms are present and are correlated with disease in Louisiana oysters. Hexamita sp. is a flagellated protozoan which can cause "breakdown of connective tissue cells, appearance of many trophozoites in blood vessels, general inflamation, and necrosis of tissue containing the dormant cyst stage of the parasite" (Galtsoff, 1964). It

is not considered a highly pathogenic parasite and reports of its presence in Louisiana waters are rare (Galtsoff, 1964; Owen, 1955).

Rare also are reports of the oyster leech, Stylochus sp. This parasite enters the open valves of diseased oysters and spat and bores keyhole perforations in the shells. The exact relationship between oyster mortalities and this organism is debatable as is the classification of the organism. Some authors (Owen, 1955) consider it a parasite, while others (Galtsoff, 1964) classify it as a predator.

Another parasite known to kill oysters is the trematode, Bucephalus gracilescens. This is an intestinal parasite, found in certain marine species, which uses the oyster as an intermediate host while growing in the gonadal tissue. Their growth can be so extensive that reproductive tissues are destroyed, thereby prohibiting the oyster from spawning. However, due to its complicated life cycle, it is not commonly found in Louisiana waters (Owen, 1955).

One further non-pathogenic organism frequently present in Louisiana oysters is the parasite Nematopsis ostrearum (Owen, 1955). It is widely distributed in waters from the Chesapeake Bay to Louisiana and has been observed encysted in the tissues of Texas oysters (Galtsoff, 1964; Hofstetter, 1967). Whereas some investigators found no direct evidence between the distribution of this parasite and reported oyster mortalities (Galtsoff, 1964) others suggest that heavy concentrations may weaken the host oyster and subject it to death from other causes (Owen, 1955).

# APPENDIX 3

## POSSIBLE CORRELATION BETWEEN ETHNIC ORIGIN AND DEVELOPMENT OF THE LOUISIANA OYSTER INDUSTRY

While the Slavonians were among the first and most well known ethnic group to be associated with oystering in Louisiana, they are not the only ones involved. As reported in the Daily Picayune (1892b,c) and early U. S. Fish Commission Reports (U.S.C.F.&F., 1887; Collins and Smith, 1891; Zacharie, 1897; 1898) "more foreign fishermen are credited to Louisiana than to any other state, nearly one third of the fishing population being made up of aliens, chiefly Italians, Austrians, Malays, Spaniards and Frenchmen." Out of a total of 4,068 fishermen recorded in Louisiana in the 1890 census, 1,299 were aliens and 423 were coloreds. It was further stated that the Gulf fisheries of Louisiana were carried out chiefly by men from the Mediterranean countries of Europe (Italians, Sicilians, Austrians from the Adriatic, Greeks and Spaniards) and by Asiatics, especially Malaysians.

A review of the public U.S. Census records for the oyster producing parishes covering the period for which occupations are given (Table 12) provides a breakdown of fishermen by parish and country of origin. Unfortunately, these data do not differentiate between the different types of fishing undertaken, rather, in most cases, they simply list the occupation as fisherman (Tables 13, 14, 15, 16). There may be several reasons why few persons gave their occupation as oysterman. First, fisherman may have been a general term used to describe all persons harvesting seafood. Second, many persons may have decribed themselves as fishermen because they harvested a variety of seafood in addition to oysters. Third, the term oysterman may not have been in common usage at the time of the census

Table 12

Census Data Available for Oyster Producing Parishes in Louisiana Between 1820 and 1880

| Parish | 1820 | 1830 | 1840 | 1850 | 1860 | 1870 | 1880 |
|---|---|---|---|---|---|---|---|
| Cameron | Occupations not listed | Occupations not listed | Occupations not listed | NA | NA | A | A |
| Iberia | | | | NA | NA | A | A |
| Jefferson | | | | A | A | A | A |
| Lafourche | | | | A | A | A | A |
| Plaquemines | | | | A | A | A | A |
| St. Bernard | | | | A | A | A | A |
| St. Mary | | | | A | A | A | A |
| Terrebonne | | | | A | A | A | A |
| Vermilion | | | | A | A | A | A |

NA - Not available
A - Available

(U.S. Census Records for Louisiana)

even though a number of persons were harvesting oysters for a living. Fourth, since many of the oystermen lived in camps scattered throughout the coastal marshes it is possible that a significant number of them were overlooked during the census.

The census data do not show a direct correlation between occupations, especially oystermen, and country of origin. However, they do indicate that a large number of the early fishermen were from areas that had a history of oystering, and it is quite possible that they brought certain skills and information with them to Louisiana that aided them in undertaking this occupation.

According to the 1850 census, only four (St. Bernard, Plaquemines, Jefferson, Terrebonne) of the nine oyster producing parishes reported any fishermen, with Plaquemines containing the most; 64.6% of the total fishermen (240) recorded (Table 13). St. Bernard had the next largest amount with 21.2% while Jefferson followed with 10.4% and Terrebonne was last with 3.8%. The four westernmost parishes of St. Mary, Iberia,

# Table 13

1850 - NUMBER OF FISHERMEN IN OYSTER PRODUCING PARISHES

(By Country of Origin)

| COUNTRY OF ORIGIN | PARISHES FROM EAST TO WEST | | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | ST. BERNARD | PLAQUEMINES | JEFFERSON | LAFOURCHE | TERREBONNE | ST. MARY | IBERIA | VERMILION | CAMERON | |
| Australia | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Austria | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Canada | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Canary Isl. | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| China | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Cuba | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Denmark | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| England | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| France | 1 | 27 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| Germany | 1 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Gibralter | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Greece | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Ireland | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Italy | 0 | 30 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 31 |
| Philippines: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Manilla | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Portugal | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Rio Colorodos | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Prussia | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Russia | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Scotland | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Spain | 24 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 32 |
| Sweden | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Switzerland | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| United States | - | - | - | - | - | - | - | - | - | - |
| Ct. | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| D. C. | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Il. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Kt. | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| La. | 17 | 2 | 3 | 0 | 6 | 0 | 0 | 0 | 0 | 28 |
| Me. | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Md. | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Ma. | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| N. J. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| N. Y. | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Oh. | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| Pa. | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| R. I. | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Vt. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Unknown | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| West Indies | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| TOTAL NO. : | 51 | 155 | 25 | 0 | 9 | 0 | 0 | 0 | 0 | 240 |
| TOTAL % : | 21.2 | 64.6 | 10.4 | 00.0 | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |

# Table 14

1860 - NUMBER OF FISHERMEN IN OYSTER PRODUCING PARISHES

(By Country of Origin)

| COUNTRY OR ORIGIN | PARISHES FROM EAST TO WEST | | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | ST. BERNARD | PLAQUEMINES | JEFFERSON | LAFOURCHE | TERREBONNE | ST. MARY | IBERIA | VERMILION | CAMERON | |
| Austria | 0 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| Brenen | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Canada: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nova Scotia | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Denmark | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| England | 5 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| France | 8 | 16 | 13 | 1 | 1 | 0 | 0 | 0 | 0 | 39 |
| Germany | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| Holland | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Ialisma | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Ireland | 2 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Italy | 3 | 2 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 12 |
| Philippines: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Manilla | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Mexico | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Norway | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Portugal | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Prussia | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Sardinia | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Scotland | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Sicily | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Spain | 165 | 6 | 27 | 1 | 0 | 0 | 0 | 0 | 0 | 199 |
| Sweden | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Turkey | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| United States: | - | - | - | - | - | - | - | - | - | - |
| In. | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Kt. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| La. | 9 | 13 | 12 | 0 | 7 | 0 | 0 | 0 | 0 | 41 |
| Me. | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Md. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Ma. | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Mi. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Mo. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| N. J. | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| N. Y. | 6 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8 |
| Oh. | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| Pa. | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Va. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Unknown | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| West Indies | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| TOTAL NO. : | 232 | 136 | 60 | 2 | 13 | 0 | 0 | 0 | 0 | 443 |
| TOTAL % : | 52.4 | 30.7 | 13.5 | 0.5 | 2.9 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |

# Table 15

1870 - NUMBER OF FISHERMEN IN OYSTER PRODUCING PARISHES

(By Country of Origin)

| COUNTRY OF ORIGIN | PARISHES FROM EAST TO WEST | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ST. BERNARD | PLAQUEMINES | JEFFERSON | LAFOURCHE | TERREBONNE | ST. MARY | IBERIA | VERMILION | CAMERON | TOTAL |
| Austria | 0 | 12 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| Bavaria | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Canary Isl. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| China | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Dalmatia | 0 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 80 |
| Denmark | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| England | 0 | 2 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| France | 0 | 13 | 59 | 1 | 3 | 0 | 1 | 0 | 0 | 77 |
| Germany | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| Greece | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Ireland | 1 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Italy | 0 | 34 | 18 | 1 | 0 | 0 | 0 | 0 | 0 | 53 |
| Mexico | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Philippines: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Manilla | 13 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| Portugal | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Prussia | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| Russia | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Saxony | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Scotland | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Sicily | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| Spain | 26 | 20 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 57 |
| Sweden | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| United States: | - | - | - | - | - | - | - | - | - | - |
| Al. | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Ct. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Ind. Ter. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| In. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Kt. | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| La. | 17 | 37 | 53 | 7 | 10 | 0 | 0 | 2 | 0 | 126 |
| Md. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Mi. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Mo. | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| N. Y. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| N. C. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Pa. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Vt. | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Unknown | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Wales | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| West Indies | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| TOTAL NO. : | 63 | 254 | 173 | 14 | 14 | 0 | 2 | 3 | 0 | 523 |
| TOTAL % : | 12.0 | 48.6 | 33.0 | 2.7 | 2.7 | 0.0 | 0.4 | 0.6 | 0.0 | 100.0 |

# Table 16

1880 - NUMBER OF FISHERMEN IN OYSTER PRODUCING PARISHES

(By Country of Origin)

| COUNTRY OF ORIGIN | PARISHES FROM EAST TO WEST | | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | ST. BERNARD | PLAQUEMINES | JEFFERSON | LAFOURCHE | TERREBONNE | ST. MARY | IBERIA | VERMILION | CAMERON | |
| Austria | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| Baden | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Canada: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nova Scotia | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| China | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| England | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| France | 0 | 3 | 15 | 0 | 1 | 0 | 0 | 0 | 0 | 19 |
| Germany | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Gibralter | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Holland | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Ireland | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Ismaigma | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Italy | 0 | 18 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| Mexico | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Philippines: | 12 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| Manilla | 17 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| Portugal | 2 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| Prussia | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Spain | 7 | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| Sweden | 0 | 8 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| Switzerland | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| United States: | - | - | - | - | - | - | - | - | - | - |
| Fl. | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Il. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Kt. | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| La. | 52 | 13 | 186 | 5 | 35 | 3 | 0 | 0 | 0 | 294 |
| Md. | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| Mi. | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| N. J. | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| N. Y. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| N. C. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Oh. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Pa. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| S. C. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Tn. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Vt. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Va. | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| West Indies | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| TOTAL NO. : | 93 | 100 | 265 | 7 | 41 | 4 | 0 | 0 | 00 | 510 |
| TOTAL % : | 18.4 | 19.6 | 59.0 | 1.4 | 8.0 | 0.7 | 0.0 | 0.0 | 0.0 | 100.0 |

Vermilion and Cameron reported no fishermen residing in their territory and neither did Lafourche Parish in the central part of Louisiana.

Of these nine parishes, Cameron, the westernmost parish, continued to report no fishermen throughout the four census periods, while the other western parishes of Vermilion, Iberia and St. Mary never recorded as much as 1.0% of the total count for the nine parishes (Tables 13, 14, 15, 16). This indicates that between 1850 and 1880, the fishing industry was concentrated in the eastern parishes of St. Bernard, Plaquemines, Jefferson, Lafourche, and Terrebonne.

Whereas Plaquemines contained the most fishermen in 1850, St. Bernard took the lead in 1860 with 52.4%. In 1870, the lead again reverted to Plaquemines with 48.6%, but by 1880, Jefferson Parish, farther to the west contained 51.9%; more than the total of St. Bernard (18.2%) and Plaquemines (19.6%) combined.

Throughout this period six countries (or states within the United States) served as the country of origin for the majority of the fishermen (Table 17) living in coastal Louisiana. Excluding native born Louisianians, the country supplying the majority of immigrant fishermen for each census date were: France (14%) in 1850, Spain (44.9%) in 1860, Austria and Dalmatia (18.0%) in 1870 and Spain (6.5%) in 1880.

Undoubtedly, few if any of these men oystered exclusively for a living. As a matter of fact, no one listed their occupation as oysterman in 1850 (Table 18). In 1860, 15 men referred to themselves as oystermen, while one man from Lafourche was an oyster saloon keeper and one man in Plaquemines Parish was an oyster canal keeper[4]. In 1870, three men

[4]Note: Due to the poor legibility of the census records this is a best-guess at the occupation listed; the word oyster was clearly deciphered.

Table 17

Fishermen in Louisiana Listed According to Place of Origin and Percentage of Total Number of Fishermen for Each Census

| Country of Origin | Percentage of Total Number of Fishermen | | | |
|---|---|---|---|---|
| | 1850 | 1860 | 1870 | 1880 |
| Austria | 1.3 | 8.8 | 2.7 | 5.5 |
| Dalmatia | 0.0 | 0.0 | 15.3 | 0.0 |
| France | 14.0 | 8.8 | 14.7 | 3.7 |
| Italy | 12.9 | 2.7 | 10.0 | 5.5 |
| Louisiana | 11.7 | 9.2 | 24.1 | 57.6 |
| Manila (Philippines) | 0.4 | 1.6 | 6.5 | 3.5 |
| Spain | 0.0 | 0.2 | 0.0 | 2.5 |
| | 13.0 | 44.9 | 10.9 | 6.5 |
| Percentage of total per year: | 53.3 | 76.2 | 84.2 | 84.8 |

(U.S. Census Data for Louisiana)

Table 18

Number of Men in Oyster Related Occupations
(As recorded in the 1850 through 1880 census records)

| Occupation | Number of persons per census | | | |
|---|---|---|---|---|
| | 1850 | 1860 | 1870 | 1880 |
| Oysterman | 0 | 15 | 0 | 0 |
| Oyster Dealer | 0 | 0 | 3 | 0 |
| Oyster Saloon Keeper | 0 | 1 | 0 | 0 |
| Oyster Canal Keeper | 0 | 1 | 0 | 0 |
| Total: | 0 | 17 | 3 | 2 |

(U.S. Census Records for Louisiana)

residing in Lafourche Parish, gave their occupation as oyster dealer. In 1880, only two oystermen were recorded and both resided in Terrebonne Parish.

Despite the contention that Slavonians pioneered in the Louisiana oyster industry (Vujnovich, 1974, Lovrich, 1960), it should be noted that none of the above mentioned oystermen were from Dalmatia or Austria. As shown in the census records for 1860, the one oysterman living in Lafourche was from France, while of the four in Plaquemines, one was from England, one from Ireland, one from Spain and the other one from Virginia. One of the oystermen in St. Bernard Parish was from Kentucky and the other was from Massachusetts. Of the eight oystermen in Terrebonne, six were native born Louisianians, while one was from Italy and the other was from New York. Of the three oystermen residing in Lafourche in 1870, one was from Spain and the other two were from Louisiana. The two oystermen recorded in Terrebonne in 1880, were both born in Louisiana.

## The Correlation Between the Origin of Louisiana Fishermen and Oystering in their Native Country

In the absence of other information, the census data alone would appear to be insufficient to establish a correlation between the origin of the immigrants and those instrumental in the development of the oyster industry in Louisiana. The primary reason for the lack of correlation is that virtually all of the fishermen engaged in the seafood industry in coastal parishes listed their occupation as fisherman without specifying a speciality such as oystering. The very few who did call themselves oystermen listed diverse places of origin and no single group would appear to be large enough to have had a controlling influence in the development of Louisiana's oyster industry.

Between 1850 and 1880 many of the fishermen in Louisiana were from places that had a previous history of oystering. Out of the six places of origin listed as supplying the majority of Louisiana fishermen, Austria-Dalmatia, France, and Italy had a well established history of oystering. Other oyster growing countries represented by fishermen in Louisiana included Canada, England, Germany, the eastern and Gulf states of the United States, Denmark, Norway, and the Netherlands.

The coastal regions of southern England, Germany, France, Italy and Dalmatia especially had a long established system of artificial cultivation of oysters. It is quite possible that persons from the coasts of western Europe and the western Mediterranean might have brought oyster harvesting techniques as well as their considerable navigation and fishing skills to coastal Louisiana during the 19th century.

With regard to the conditions of oyster cultivation in western Europe in the 19th century, Mobius (1880) observed that oystering was well established in several countries from Germany to the Mediterranean. He noted that the entire coast of France from Cette to Toulon provided oysters, especially the large salt lakes of Montpellier and Cette. He further commented that "the extraordinary fruitfulness of the oyster beds along the west coast of France is the result of the careful preservation of a rich stock of mature breeding oysters upon the natural banks, especially in the Bay of Arcachon, on the coast of Brittany near Auray, and on the coast of Normandy near Saint-Vaast-de-la-Hague, Cancale and Granville." However, overfishing had led to the depletion of formerly rich beds along some segments of the west coast of France between 1850 and 1860.

Depletion of natural oyster beds was also occurring elsewhere in

Europe at about this same time and in response to these circumstances, individuals and governments were beginning to investigate the possibility of artificial cultivation. By the late 19th century, these ideas were spreading to areas of the United States where overfishing had also reduced the natural harvest in some areas. While Louisiana retained highly productive oyster bottoms well into the 20th century, certain locations did experience natural reef extinction and some persons in those areas were forced to resort to artificial methods of cultivation. Many of the cultivation techniques were similar or slightly modified from the harvesting and cultivation techniques practiced in Europe. It is probably not a coincidence that some of the earliest practioners of these methods (Slavonians, Italians, and French) were from regions in Europe that had been undertaking some form of artificial cultivation for quite a number of years.

Some of the earliest attempts to reestablish oyster reefs in France were tried by Professor P. Coste in the Bay of Saint Brieve on the north coast of Brittany in 1858. He in turn got many of his ideas for those experiments after observing oyster cultivation in Lake Fusaro, Italy (Fig. 31). The methods employed at Lake Fusaro were reputed to be the same as those instituted by Sergius Orata, a Roman knight of the 7th century (Bouchon-Brandely, 1880). This particular process, however, was apparently unique even in Italy for de Bon (1875) noted that it was an entirely local industry:

> ...the keepers of these parks, had, from time immemorial been in the habit of collecting the spat upon stakes driven around their deposits (Fig. 32), and upon bundles of fagots suspended from ropes stretched above the water ...it had not extended to the other districts of Italy, not even to the adjacent ones, and it was not at all commonly known.

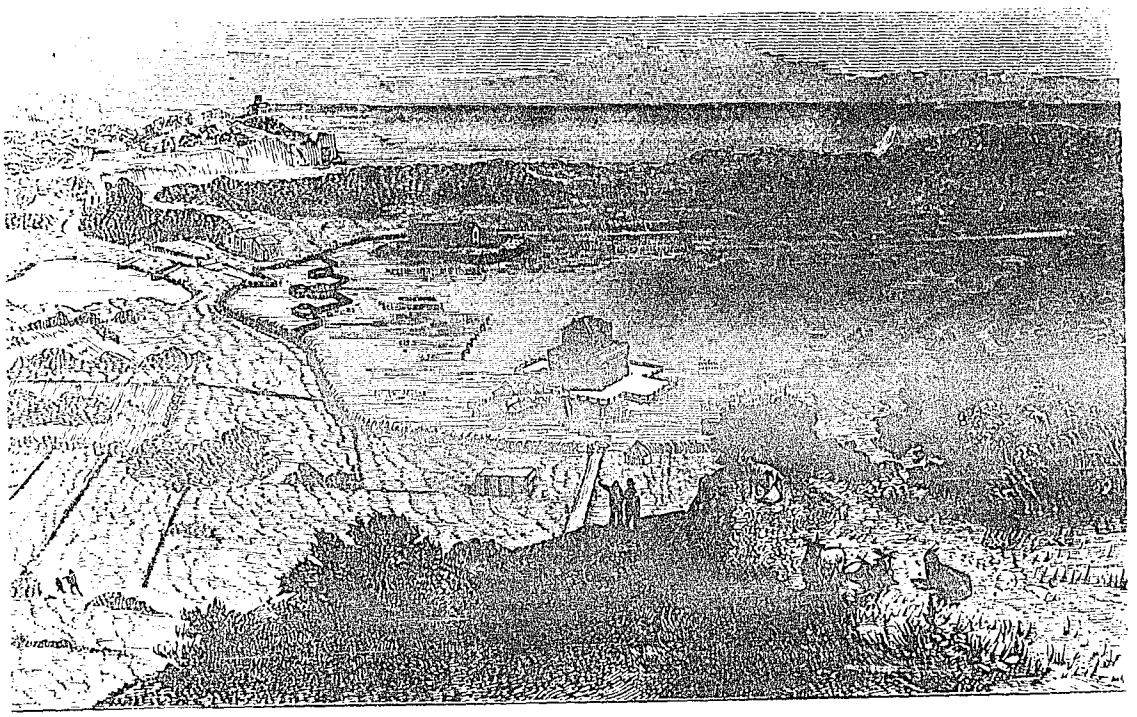


Fig. 31 Oyster cultivation in Lake Fusaro, Italy in the mid-19th century (U.S.C.F.&F., 1883).

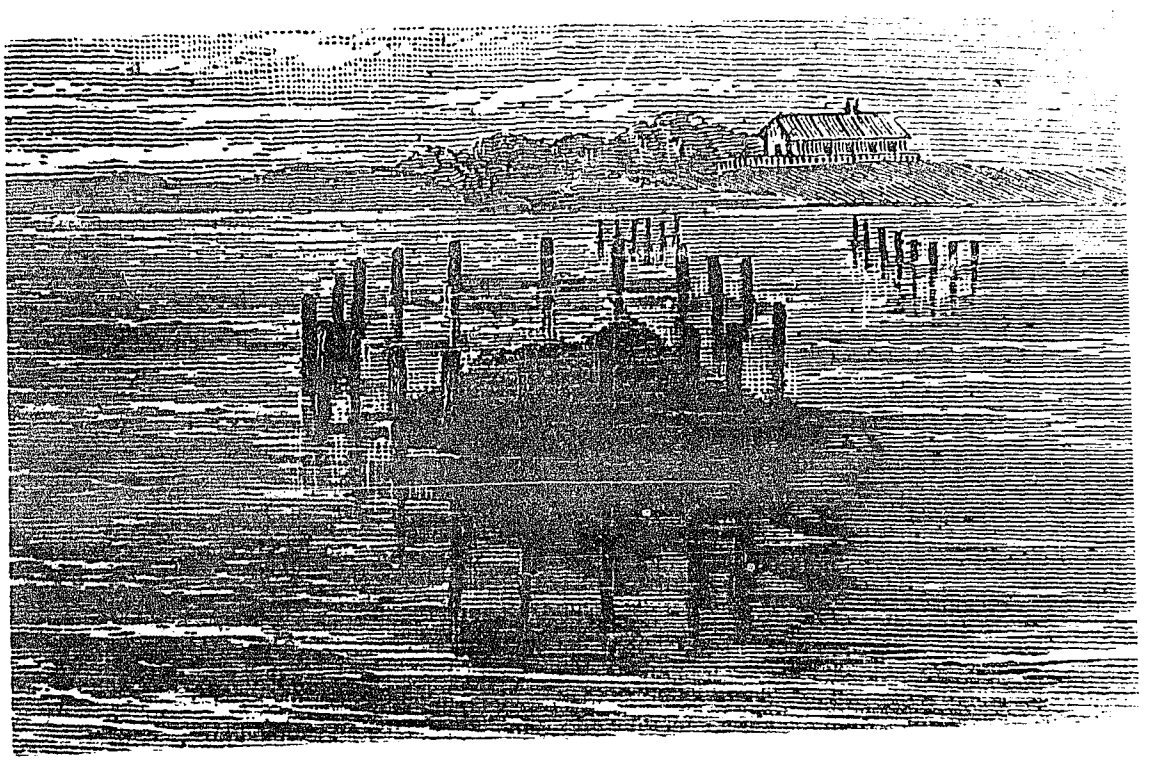


Fig. 32 Collection of spat on stakes driven around oyster deposits in Lake Fusaro, Italy (U.S.C.F.&F., 1883).

Oysters consumed elsewhere in Italy were gathered "by hand even from considerable depth" along the coasts of the Adriatic Sea and ponds of Corsica and consumed locally (Bouchon-Brandely, 1880). De Bon (1875) concluded his report on the condition of oyster culture by stating that "...it was in France, some 20 years ago, that oyster culture really had its origin."

It is interesting to note that the industry at Lake Fusaro, having existed since Roman times, came to an end in 1869. In that year, the Neapolitan government, attempting to improve water quality in the lake dug a canal to the sea. The resulting currents rushing through the canal stirred up the bottom sediment, introduced sands into the lake and in general changed the character of the bottom thereby rendering it unsuitable for oyster cultivation (Bouchon-Brandely, 1880).

Oyster harvesting was widespread in many of the coastal regions of western Europe by the late 19th century. They were grown along the southern and eastern coasts of England and especially in the vicinity of Whitstable, Colchester and Burnham. These areas had a very long history of oyster growing with one company at Whitstable claiming to have been in business for several hundred years (Mobius, 1880).

Oysters were also grown in Denmark on a very limited scale and even the government of Norway, in the mid-19th century attempted to artificially cultivate oysters (Bouchon-Brandely, 1880). The government of the Netherlands in 1870, stepped in to try to promote the declining oyster industry there. Because of depletion of the natural stock (attributed to overfishing), the government decided to rent out the producing oyster beds, in small portions, in the large Yersete oyster beds in the Zeeland and in the Lavwer Sea (Hoek, 1880) in hopes of encouraging private individuals to

take better care of the brood oysters.

A familarity with oysters and oyster gathering or cultivation in the mid-19th century was also present along the northwestern coast of Germany on the sea flats of Schleswishe-Holstein. The extent and condition of oystering in this area was well documented by Mobius (1880) who also developed in this classic study, the concept of an oyster bank as a bioconose or social community. By presenting the fundamental bioconose laws which govern the establishment, growth and perpetuation of an oyster community, he greatly influenced the later European and North American experiments on artificial oyster cultivation and management as well as legislation that emerged during this period to protect natural oyster reefs. His report was translated from German and reprinted in the United States Fisheries Bulletin (U.S.C.F.&F., 1880). It served as a guide for United States Fisheries biologists and officials working on oyster studies in the United States. Many of the early United States biological reports, including Moore's study (1898) of oyster growing conditions in Louisiana, reiterated Mobius' position that certain bioconose laws, especially maintenance of a brook stock on the natural reef structure, must be observed if the community was to remain self perpetuating and commercially productive.

In addition to the immigrants to Louisiana from western Europe, the United Kingdom and the Mediterranean countries, those from the east coast of the United States could also have been familiar with oystering as a professional occupation. Mobius (1880) observed that "...very few efforts have been made in North America to catch and grow oysters artificially according to the French system..." because "...the natural banks produce such an abundance of young oysters that all the beds artificially planted

can be abundantly and cheaply supplied from them..." However, these comments were geared to oystering along the Atlantic coast because he only acknowledged oyster production from the St. Lawrence to Cape Hatteras. His omission of a discussion of the industry along the Gulf coast may indicate that this area did not have an internationally well known oyster industry in the mid-19th century.

Because a few of the Louisiana fishermen recorded in the Federal Census (1850, 1860, 1870 and 1880) were from the east coast of the United States and Canada, it is possible that they could have brought some knowledge of oyster harvesting to Louisiana. For example, the Maritime Provinces of Canada (New Brunswick, Nova Scotia and Prince Edward Island) reached their peak of oyster production in the latter part of the 19th century, but declined steadily from 1890 to 1920, because of "...overfishing, disease, predation by starfish, and elimination of beds by heavy stands of eelgrass"(Matthiessen, 1970).

The New England states of Maine, Massachusetts, Rhode Island and Connecticut are unique in that they developed one of the earliest oyster industries in North America in response to high market demand from urban areas and subsequently "...experienced the sharpest decline in oyster production of any region in North America"(Matthiessen, 1970). As late as the latter half of the 19th century, oyster production was declining in this area at the same time that a number of New England fishermen were arriving in Louisiana. One of the two oystermen in St. Bernard Parish in 1860 was from Massachusetts.

Oyster harvesting was also well developed in the mid-Atlantic states of New York, New Jersey, Pennsylvania and Delaware by the late 19th century, but also on the decline due to lack of seed oysters. By the first

decade of the 20th century it had disappeared entirely from Pennsylvania. All of these states except Delaware were represented by fishermen in Louisiana in the late 19th century and one of the eight oystermen in Terrebonne Parish in 1860 was from New York (Matthiessen, 1970; U.S. Census, 1860).

One of the four oystermen recorded in Plaquemines Parish in 1860 was originally from Virginia. This state borders on the Chesapeake Bay which traditionally has been the leading producer of oysters in North America (Matthiessen, 1970). It is also recognized that many of the oyster laws adopted by Louisiana between the 1880s and early 20th century were modeled on the more enlightened aspects of the oyster laws of Virginia and Maryland, so the influence from this region should be recognized with regard to Louisiana's oyster legislation and the bearing it had on the development of the industry (Daily Picayune, 1902).

While fishermen in Louisiana also immigrated from other south Atlantic and Gulf states that contained oysters in their coastal waters, it is less likely that they contributed significantly to a flow of knowledge of the industry from these areas. The reason for this is that during the late 19th century the coastal states of North and South Carolina, Georgia, Florida and Alabama had a poorly developed industry that existed largely in response to demand for local consumption (Kellogg, 1910; Churchill, 1920).

In view of the late 19th century decline in oyster production in some eastern states and Canada, it is possible that a few of the fishermen migrated to Louisiana in search of more productive oyster beds that would allow them to pursue their occupations. However, because they were few in number and scattered throughout the oyster producing parishes

of Louisiana, it is unlikely that they exerted a major influence on the development of the Louisiana industry. The problems with oyster production in these northern states, as well as the declines in harvest did, however, influence the Louisiana industry in that they served as an example of what could happen to Louisiana's oysters unless conservation measures were enacted into legislation and streneously enforced. Writing on the United States shellfish industries, Kellogg (1910) commented that Louisiana was unique among other states in that "...while the greater part of its product had been derived from natural beds, it has not waited until these were destroyed before searching for some other source of supply, but had energetically and intelligently encouraged oyster culture."

APPENDIX 4

OYSTER LEASE DATA--1902

| LEASE | OWNER | LOCATION | SIZE (acres) | PARISH |
|---|---|---|---|---|
| 1 | J. R. Brown | Whale Bay | 12.27 | Pla. |
| 2 | R. S. Leovy | Grand Bay | 8.30 | " |
| 3 | D. Collette | Quarantine Bay | 10.00 | " |
| 4 | G. Parun | Grand Bay | 5.36 | " |
| 5 | G. H. Dunbar | Lake Boudreau | 20.00 | St. Ber. |
| 6 | F. B. Dunbar | " | 20.00 | " |
| 7 | W. Conseil | " | 18.00 | " |
| 8 | F. B. Dunbar | " | 20.00 | " |
| 9 | G. W. Dunbar | " | 20.00 | " |
| 10 | F. F. Dunbar | " | 20.00 | " |
| 11 | A. L. Gaudin | " | 17.00 | " |
| 12 | J. Hessler | " | 5.00 | " |
| 13 | E. A. Dunbar | " | 20.00 | " |
| 14 | J. Radetich | Bayou LaChute | 0.63 | Pla. |
| 15 | J. Stepercovich | Bayou Cook | 0.55 | " |
| 16 | N. Gojkovich | " | 1.06 | " |
| 17 | A. Radovich | Bayou LaChute | 0.56 | " |
| 18 | A. Rudolf | Bayou Cook | 1.57 | " |
| 19 | P. E. Peterson | Bay Adams | 10.00 | " |
| 20 | C. A. Bennen | Bordelles Bay | 10.00 | " |
| 21 | L. Cazezu | Bay Coquette | 3.00 | " |
| 22 | F. Adam | Bay Labarge (Grand Is.) | 10.00 | Jef. |
| 23 | F. J. Lobrano & F. McLaughlin | Whale Bay | 3.00 | Pla. |
| 24 | Name Missing | Whale Bay | 3.00 | " |
| 25 | M. Busko | Bayou LaChute | 1.50 | " |
| 26 | A. Pelagalli | Blind or Pardee Bay | 2.00 | " |
| 27 | Barnum Scofield & Co. | Quarantine Bay | 20.00 | " |
| 28 | J. L. Buras | Buras Ditch | 10.00 | " |
| 29 | J. Riquard | Quarantine Bay | 10.00 | " |
| 30 | T. Kego & Co. or Kato & Lintich | " | 10.00 | " |
| 31 | P. Cuselich & Co. | " | 20.00 | " |
| 32 | J. F. Reese | " | 20.00 | " |
| 33 | J. Yuratich & Bro. | " | 10.00 | " |
| 34 | V. Barrios | " | 10.00 | " |
| 35 | J. Fiscovich & Bro. | " | 20.00 | " |
| 36 | N. Riquard & Co. | Bordell's Bay | 12.25 | Pla. |
| 37 | R. Cook | Quarantine Bay | 10.00 | " |
| 38 | G. W. Hingle, Jr. | " | 10.00 | " |
| 39 | S. Castella | " | 10.00 | " |
| 40 | J. Conaway | Whale Bay | 5.00 | " |
| 41 | A. Suhor | West Bay | 5.00 | " |
| 42 | G. Guesdorf | " | 5.00 | " |
| 43 | J. J. Williams | " | 5.00 | " |
| 44 | F. L. Miller | Whale Bay | 10.00 | " |
| 45 | P. Spongia | Long Bayou | 10.00 | " |
| 46 | L. Spongia | " | 6.00 | " |

| LEASE | OWNER | LOCATION | SIZE | PARISH |
|---|---|---|---|---|
| 47 | P. Spongia | Long Bayou | 10.00 | Pla. |
| 48 | W. Miller | W of S Pass | 6.75 | " |
| 49 | A. Johnson | West Bay | 5.00 | " |
| 50 | E. Anderson | " | 5.00 | " |
| 51 | C. Anderson | Bay Anderson | 10.00 | " |
| 52 | J. Marinovich & Co. | Quarantine Bay | 20.00 | " |
| 53 | T. Bossnich & Co. | " | 20.00 | " |
| 54 | L. Benen | Gaspar Bay | 10.00 | " |
| 55 | J. Limtich & Co. | Quarantine Bay | 10.00 | " |
| 56 | W. P. Hingle | Coquille Bay | 10.00 | " |
| 57 | L. Diemell | Whale Bay | 10.00 | " |
| 58 | S. H. Crevassol | Quarantine Bay | 10.00 | " |
| 59 | J. McLaughlin | Whale Bay | 10.00 | " |
| 60 | L. Scobel | Bayou LaChute | 1.00 | " |
| 61 | A. Galmiche | Bayou Fontenelle | 3.77 | " |
| 62 | B. Vucassovich | Bayou Ferren | 3.00 | " |
| 63 | P. J. Rihner | Bay Adam | 2.00 | " |
| 64 | P. Yuratich | Bayou LaChute | 3.00 | " |
| 65 | T. L. Zibilich | Bay Adam | 1.16 | " |
| 66 | A. Bosco | " | 6.50 | " |
| 67 | P. J. Rihner | Bayou Cheni | 10.00 | " |
| 68 | J. Dymond, Jr. | Bay Adam | 9.00 | " |
| 69 | R. Dykers (Dylsen) | " | 20.00 | " |
| 70 | N. S. Dymond | " | 20.00 | " |
| 71 | A. E. Hebert | " | 20.00 | " |
| 72 | W. A. Rodriquez | " | 20.00 | " |
| 73 | F. M. Stockfleth | " | 3.33 | " |
| 74 | A. Bowers | " | 10.00 | " |
| 75 | J. Barbier | Grand Bay (Bastian) | 9.00 | " |
| 76 | P. J. Rihner | Bayou Cook | 5.00 | " |
| 77 | J. Johnson | Bay Coquette | 10.00 | " |
| 78 | J. Frelich | Bayou Courant | 3.00 | " |
| 79 | T. Bulot | Shell Island Bay | 5.00 | " |
| 80 | S. M. Fucich | Cornelius Bay | 9.96 | " |
| 81 | G. de Armas | Quarantine Bay | 20.00 | " |
| 82 | T. Cacich | " | 10.00 | " |
| 83 | L. Boraco | " | 10.00 | " |
| 84 | H. Naccari | Bay des Islet | 110.00 | Jef. |
| 85 | R. Legier | Quarantine Bay | 20.00 | Pla. |
| 86 | O. Coulon & Son | Bay des Islet | 10.00 | Jef. |
| 87 | J. Buras | Quarantine Bay | 10.00 | Pla. |
| 88 | P. Doullut | Bay Adam | 20.00 | " |
| 89 | W. A. Mevers | " | 20.00 | " |
| 90 | W. Legende | " | 20.00 | " |
| 91 | J. Perrin | Bay Coquille | 10.00 | Jef. |
| 92 | W. Harris | California Bay | 9.50 | Pla. |
| 93 | L. Scobel | Bayou LaChute | 6.00 | " |
| 94 | G. Lingoni | California Bay | 10.00 | " |

| LEASE | OWNER | LOCATION | SIZE | PARISH |
|---|---|---|---|---|
| 95 | L. F. Jeanfreau | Spanish Bay Pass | 10.00 | Pla. |
| 96 | E. Naccari | Bay des Islet | 10.00 | Jef. |
| 97 | E. Anderson | Mullet Bayou | 3.04 | Pla. |
| 98 | C. Browne | Cox's Bayou | 5.00 | " |
| 99 | A. Calvo | Harris Bayou | 1.80 | " |
| 100 | F. Estopinal | Quarantine Bay | 20.00 | " |
| 101 | A. Naccari | Bay des Islet | 10.00 | Jef. |
| 102 | Victor Lingoni | Spanish Bay Pass | 10.00 | Pla. |
| 103 | J. F. Bowers | Bay Adam | 7.00 | " |
| 104 | J. D. Fateo | Harris Bayou | 4.84 | " |
| 105 | A. T. Petrovich | Bay Adam | 12.74 | " |
| 106 | A. Cariddi | Harris & Lawsuit Bay. | 5.00 | " |
| 107 | J. J. Kelly | Bank Marro Bay | 10.00 | " |
| 108 | P. D. Kelly & Co. | Bordelle Bay | 10.00 | " |
| 109 | J. Slabich | Jack's Camp Bay | 10.00 | Laf. |
| 110 | L. Broussard | Timbalier Bay | 10.00 | " |
| 111 | F. Rhodes | Bay Bayou Jack | 10.00 | Ter. |
| 112 | V. Fortunato | Timbalier Bay | 10.00 | Laf. |
| 113 | D. Guidry | Pass Laurent Bay | 10.00 | Ter. |
| 114 | E. Engeran | Bay Bayou Jack | 10.00 | " |
| 115 | B. Cunnighen | Bay Negresse | 10.00 | " |
| 116 | M. Frazier | Oyster Bayou | 12.10 | " |
| 117 | G. Freeman | Bayou LaGrece | 10.00 | " |
| 118 | E. Doumeing | Bay Negresse | 10.00 | " |
| 119 | J. Porobilo | Timbalier Bay | 10.00 | Laf. |
| 120 | J. Lafont | Jack's Camp Bay | 10.00 | " |
| 121 | F. Naquin | Grand Bayou Jack | 10.00 | Ter. |
| 122 | G. Rhodes | Bay Negresse | 10.00 | " |
| 123 | E. Rhodes | Grand Bayou Jack | 10.00 | " |
| 124 | M. Durmont | Bay Negresse | 10.00 | " |
| 125 | T. Dumont | " | 10.00 | " |
| 126 | E. Rhodes | Grand Bayou Jack | 10.00 | " |
| 127 | D. Nelton | Little Bayou du West | 10.00 | " |
| 128 | N. Nelton | Bayou Jack Bay | 10.00 | " |
| 129 | J. Dymond, Jr. | Bay Adam | 11.00 | Pla. |
| 130 | Dymond & Dykers | " | 20.00 | " |
| 131 | Dymond & Rodriquez | " | 20.00 | " |
| 132 | Dymond & Hebert | " | 20.00 | " |
| 133 | D. Wolf | Jack Stout Bay | 10.00 | Ter. |
| 134 | C. A. Johnson | Bay Castagnet | 20.00 | " |
| 135 | A. St. Martin | Sister Lake (Caillou) | 20.00 | " |
| 136 | R. Terbonne | Bay Castagnett | 10.00 | " |
| 137 | W. Nini | Mud Hole Bayou | 10.00 | " |
| 138 | S. Wolf | Jack Stout Bay | 20.00 | " |
| 139 | O. Plassale | Mud Hole Bay | 10.00 | " |
| 140 | E. M. Marquez | Bay Castagnet | 10.00 | " |
| 141 | A. J. Henry | Jack Stout Bay | 20.00 | " |
| 142 | C. Angeran | Mud Hole Bay | 10.00 | " |

| LEASE | OWNER | LOCATION | SIZE | PARISH |
|---|---|---|---|---|
| 143 | J. Henry | Jack Stout Bay | 10.00 | Ter. |
| 144 | J. Henry | " | 10.00 | " |
| 145 | C. Angeran | Mud Hole Bay | 10.00 | " |
| 146 | O. Nini | " | 10.00 | " |
| 147 | O. Plassale | Mud Hole Bayou | 10.00 | " |
| 148 | A. Lodrigue | Mud Hole Bay | 10.00 | " |
| 149 | F. St. Martin | Sister Lake | 20.00 | " |
| 150 | A. Lodrigue | Mud Hole Bay | 10.00 | " |
| 151 | C. Chofalo | Bay Castagnet | 10.00 | " |
| 152 | F. M. Tive | Lake Mechant | 10.00 | " |
| 153 | E. Petty | Little Indian Bay | 10.00 | " |
| 154 | J. Henry | Jack Stout Bay | 10.00 | " |
| 155 | A. Naquin | Mud Hole Bay | 20.00 | " |
| 156 | W. Sandros | Bay Castagnet | 10.00 | " |
| 157 | D. Egle | Jack Stout Bay | 12.00 | " |
| 158 | D. Wolf | " | 10.00 | " |
| 159 | F Keiff | Sister Lake | 10.00 | " |
| 160 | A. Adams | " | 10.00 | " |
| 161 | J. Angeran | " | 20.00 | " |
| 162 | X. St. Martin | " | 20.00 | " |
| 163 | C. Baudin | " | 10.00 | " |
| 164 | A. Terrebonne | Jack Stout Bay | 10.00 | " |
| 165 | L. Nini | Mud Hole Bay | 10.00 | " |
| 166 | A. Terrebonne | Jack Stout Bay | 10.00 | " |
| 167 | C. Plassale | Mud Hole Bay | 10.00 | " |
| 168 | H. A. Theriot | Sister Lake | 20.00 | " |
| 169 | B. Billiot | Bay Provansal | 10.00 | " |
| 170 | C. Theriot | Sister Lake | 20.00 | " |
| 171 | A. Adam | " | 10.00 | " |
| 172 | M. Marcel | Mud Hole Bayou | 10.00 | " |
| 173 | M. Marcel | " | 10.00 | " |
| 174 | J. Henry | Jack Stout Bay | 10.00 | " |
| 175 | E. Adam | Mud Hole Bay | 10.00 | " |
| 176 | A. Adam | Sister Lake | 10.00 | " |
| 177 | C. Plassale | Mud Hole Bay | 10.00 | " |
| 178 | C. Head | Jack Stout Bayou | 10.00 | " |
| 179 | C. Gaspard | Mud Hole Bay | 10.00 | " |
| 180 | H. A. Theriot | Sister Lake | 20.00 | " |
| 181 | E. Henry | Little Indian Bayou | 20.00 | " |
| 182 | D. Egle | Bay Castagnet | 10.00 | " |
| 183 | C. Head | Jack Stout Bay | 10.00 | " |
| 184 | D. Ribardi | Mud Hole Bay | 10.00 | " |
| 185 | F. A. Theriot | Bay Aux Huitres | 20.00 | " |
| 186 | A. J. Bonvillain | " | 20.00 | " |
| 187 | X. H. St. Martin | " | 20.00 | " |
| 188 | C. St. Martin | " | 20.00 | " |
| 189 | H. C. Boudreaux | Grand Cailloux Bay | 20.00 | " |
| 190 | A. Kristicevic | Bay Jeanup | 10.00 | " |

| LEASE | OWNER | LOCATION | SIZE | PARISH |
|---|---|---|---|---|
| 191 | J. Krile | Hell Hole Lake | 10.00 | Ter. |
| 192 | E. Bourg | Grand Cailloux Bayou | 20.00 | " |
| 193 | S. Defilice | Bayou Tambour | 15.00 | " |
| 194 | A. Benoit | Grand Cailloux Bay | 20.00 | " |
| 195 | N. Kacanich | Bayou Girod | 10.00 | " |
| 196 | J. Krileia | Big Hell Hole Bayou | 10.00 | " |
| 197 | A. Cuneo | Cat Island Lake | 10.00 | " |
| 198 | L. A Zibilich | Bayou des Huitres | 9.98 | " |
| 199 | J. Cotton | Bay Crocodile (Cocodrie) | 10.00 | " |
| 200 | C. Fabre | W Bay Jeanup | 10.00 | " |
| 201 | P. B. Petty | Jack Stout Bay | 10.00 | " |
| 202 | R. Bourg | Grand Caillou Bayou | 20.00 | " |
| 203 | R. Bourg | Olive Bay. (") | 10.00 | " |
| 204 | L. Bourg | St. Helene/Coonrod Bay. | 10.00 | " |
| 205 | A. M. Dupont | Bay. Lucien/Terrebonne | 10.00 | " |
| 206 | M. Petty | Jack Stout Bay | 10.00 | " |
| 207 | M. Authement | Bay Chaland | 10.00 | " |
| 208 | A. Daspit | Lake Chaland | 10.00 | " |
| 209 | B. Keiff | Bay Crocodile (Cocodrie) | 10.00 | " |
| 210 | L. Voisin | Bay Bois Connu | 10.00 | " |
| 211 | F. Belamour | Bay du Nord | 10.00 | " |
| 212 | R. Bourg | Yves Bay | 10.00 | " |
| 213 | F. Le Boeuf | Bay Bois Connu | 10.00 | " |
| 214 | J. Luke | Bayou Grand Cailloux | 10.00 | " |
| 215 | V. Solet | Bay Bois Connu | 10.00 | " |
| 216 | L. Liner | Bayou du Nord | 5.00 | " |
| 217 | L. Gouaux | Bayou Couteau | 20.00 | " |
| 218 | J. Carlos | Bay Armand | 20.00 | " |
| 219 | T. Engeran | Oyster Bayou | 7.75 | " |
| 220 | L. Nini | Mud Hole Bay | 10.00 | " |
| 221 | M. Plassala | " | 10.00 | " |
| 222 | O. Rodrique | King Lake | 10.00 | " |
| 223 | N. Thibodaux | Severn Bay | 10.00 | " |

(Source: Oyster leases applied for in 1902 and recorded by 1903, Louisiana Department of Conservation, New Orleans, Louisiana)

# Vita

Karen M. Wicker was born in Westmoreland County, Virginia, on July 5, 1948. She was graduated from Washington and Lee High School, Montross, Virginia in 1966, and later received a B.A. in American Studies from Mary Washington College of the University of Virginia in 1970. After working for two years at the Smithsonian Institution in Wasington, D.C., she attended an archaeology field camp in 1972, at St. Mary's City, Maryland, under the sponsorhip of George Washington University and the Smithsonian Institution. She received her M.S. degree in Geography from Louisiana State University in 1975. As a partial fullfilment for this degree she wrote a thesis on "Recent Changes in Physiography of Buffalo Cove, Atchafalaya Basin, Louisiana." While in the masters program, she was a research assistant at various times for L. S. U. Sea Grant, the Environmental Protection Agency and Coastal Environments, Inc. doing habitat evaluation and floodplain management plans for the Atchafalaya Basin. During the 1976-77 term she taught a course in physical geography at Louisiana State University. She is presently a research associate in the field of enviornmental assessment, landuse planning and management at Coastal Environments, Inc. in Baton Rouge.

# EXAMINATION AND THESIS REPORT

Candidate: Karen M. Wicker

Major Field: Geography

Title of Thesis: THE DEVELOPMENT OF THE LOUISIANA OYSTER INDUSTRY IN THE 19TH CENTURY

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

February 20, 1979